Monitoring the Migrations of Wild Snake River Spring/Summer Chinook Salmon Juveniles, 2008-2009

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EXECUTIVE SUMMARY

This report provides results from an ongoing project to monitor the migration behavior and survival of PIT-tagged wild juvenile spring/summer Chinook salmon in the Snake River Basin. Data reported are from detections of these fish from late summer 2008 to mid-2009. In summer 2008, the National Marine Fisheries Service (NMFS) tagged fish in Idaho streams and the Oregon Department of Fish and Wildlife (ODFW) tagged fish in Oregon streams. Our analyses include migration behavior and estimated survival of study fish detected at instream monitors, as well as their arrival timing and estimated survival to Lower Granite Dam. Principal results from tagging and interrogation during 2008-2009 are listed below:

1) In July and August 2008, we PIT tagged and released 9,718 wild Chinook salmon parr in 14 Idaho streams or sample areas.

2) Overall observed mortality from collection, handling, tagging, and after a 24-h holding period was 1.4%.

3) Of the 2,520 Chinook salmon parr tagged and released in Valley Creek in summer 2008, 591 (23.5%) were detected at two instream PIT-tag monitoring systems in lower Valley Creek from late summer 2008 to spring 2009. Of these, 70.7% were detected in late summer or fall, 20% in winter, and 9.3% in spring. Estimated parr-to-smolt survival to Lower Granite Dam was 21.8% for the late summer/fall group, 54.8% for the winter group, and 27.1% for the spring group. Based on detections at downstream dams, the overall detection efficiency of upper (VC1) or lower (VC2) Valley Creek monitors was 45.6%.

   Using this detection efficiency, an estimated 34.8% of all summer-tagged parr survived to move out of Valley Creek, and their estimated survival to Lower Granite Dam was 27.3%. Overall estimated parr-to-smolt survival for all summer-tagged parr from this stream at the dam was 10.8%. Development and improvements of the instream PIT-tag monitoring systems continued throughout 2008-2009.

4) Of the 942 Chinook salmon parr tagged and released in upper Big Creek in summer 2008, 49 (5.2%) were detected at two instream PIT-tag monitoring systems in lower Big Creek at Taylor Ranch from late summer 2008 to spring 2009. Of these, 65.3% were detected in late summer or fall, 20.4% in winter, and 14.3% in spring. Estimated parr-to-smolt survival to Lower Granite Dam was 14.5% for the late summer/fall group, 0% for the winter group, and 100.0% (modeled survival was 106%) for the spring group. Based on detections at downstream dams, the overall detection efficiency of upper (TAY-a) or lower (TAY-b) Taylor Ranch monitors was 9.4%.

   Using this detection efficiency rate, we estimated 55.2% of all summer-tagged parr from upper Big Creek survived to Taylor Ranch on lower Big Creek. Estimated survival of these fish from the Taylor Ranch monitors to Lower Granite Dam was

24.6%. Overall estimated parr-to-smolt survival to the dam for all summer-tagged parr from this stream (area) was 11.4%.

Of the 871 Chinook salmon parr PIT tagged and released in lower Big Creek in summer 2008, 118 (13.5%) were detected at two instream PIT-tag monitoring systems at Taylor Ranch in lower Big Creek from late summer 2008 to spring 2009. Of these, 57.6% were detected in late summer or fall, 36.4% in winter, and 5.9% in spring. Estimated parr-to-smolt survival to Lower Granite Dam was 24.0% for the late-summer/fall group, 41.2% for the winter group, and 0% for the spring group. Based on detections at downstream dams, the overall efficiency of upper (TAY-a) or lower (TAY-b) Big Creek monitors for detecting these fish was 15.3%.

Using this efficiency rate, an estimated 88.5% of all summer-tagged parr survived to the lower Big Creek monitors, and their estimated survival from that point to Lower Granite Dam was 28.9%. Overall estimated parr-to-smolt survival for all summer-tagged parr from this stream (area) at the dam was 30.0%. Increasing the number of fish tagged and/or the number of antennas should provide better precision for these survival estimates in the future.

5) At Little Goose Dam in 2009, lengths and/or weights were taken on 763 recaptured fish from 14 Idaho stream populations. Fish had grown an average of 36.1 mm in length and 8.1 g in weight over an average of 271 d. Their mean condition factor declined from 1.27 at release (parr) to 1.04 at recapture (smolt).

6) Mean length at release was significantly larger for fish detected than for fish not detected the following spring and summer ($P < 0.0001$).

7) Fish that arrived at Lower Granite Dam in April and May were significantly larger (FL) at release than fish arriving after May ($P < 0.0001$), although only 27 fish migrated after May.

8) In 2009, peak detections at Lower Granite Dam of parr tagged during summer 2008 (from the 14 stream populations in Idaho and 4 streams in Oregon) occurred on 28 April during moderate flows (91.1 kcfs) and 19 May during high flows (139.8 kcfs). Respective dates of the 10th, 50th, and 90th passage percentiles were 23 April, 2 May, and 20 May.

9) In 2008-2009, estimated parr-to-smolt survival to Lower Granite Dam for wild smolts from Idaho and Oregon streams combined averaged 17.7% (range 10.8-30.0% depending on stream of origin). For fish from Idaho streams, average estimated parr-to-smolt survival was 17.9%.

In 2009, we observed moderate-to-high flows throughout the spring migration season, with the highest flows later in the season accompanied by weather that was cooler and wetter than normal in the Snake River basin. These conditions moved 50% of the wild fish through Lower Granite Dam by 2 May; continued moderate-to-high flows moved 90% of the fish through the dam over the following 18 days. Clearly, complex interrelationships of several factors drive the annual migrational timing of the stocks.

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INTRODUCTION

This report provides information on PIT-tagging of wild Chinook salmon parr in Idaho in 2008 and the subsequent monitoring of these fish and similarly tagged fish from Oregon. We report estimated survival and arrival timing to Lower Granite Dam of these Chinook salmon juveniles, as well as interrogation data from these fish collected at several other sites throughout the Snake and Columbia River system. This research continues studies that began under Bonneville Power Administration (BPA) funding in 1991. Results from previous study years were reported by Achord et al. (1994, 1995a,b; 1996a,b, 1997, 1998, 2000, 2001a,b, 2002-2009). The goals of this ongoing study are to:

1) Characterize migration timing and estimate parr-to-smolt survival to Lower Granite Dam for different stocks of wild Snake River spring/summer Chinook salmon.
2) Determine whether consistent migration patterns are apparent.
3) Determine what environmental factors influence these patterns.
4) Characterize the migrational behavior and estimate survival of different wild juvenile fish stocks as they migrate from their natal rearing areas.

This study provides critical information for recovery planning, and ultimately recovery for these wild fish stocks, which are listed as threatened under the U.S. Endangered Species Act.

During 2008-2009, we collected water temperature, dissolved oxygen, specific conductance, turbidity, water depth, and pH data at six monitoring stations, in the Salmon River Basin, Idaho for the Baseline Environmental Monitoring Program. In addition, in summer and fall 2008, we installed Level TROLL® 300[1] monitoring instruments (In-Situ Inc., Ft. Collins, CO), which measured hourly water temperature and depth parameters in 10 additional streams. These environmental data can be compared with parr/smolt migration, survival, and timing data to discern patterns or characteristic relationships that may exist and that may help in recovery planning for threatened stocks.

[1] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

METHODS

Fish Collection and Tagging

The Oregon Department of Fish and Wildlife (ODFW) PIT tagged wild Chinook salmon parr in the Grande Ronde and Imnaha River drainages in northeast Oregon in 2008. All tagging, detection, and timing information for fish from these streams in 2008-2009 will be reported by ODFW. However, with ODFW's concurrence, we report here the timing and overall estimated survival at Lower Granite Dam of fish tagged in summer 2008 from these Oregon streams.

National Marine Fisheries Service (NMFS) personnel tagged fish in Idaho streams during 2008 using the safe handling methods developed for the wild fish study. These handling methods are detailed in Matthews et al. (1990) and in previous reports from this study (Achord et al. 1994; 1995a,b; 2003; 2004). However, since we observed no significant differences between mortality rates before and after oxygen use during tagging operations in this study (Achord et al. 2007b); we discontinued using oxygen during tagging (but not during collection operations) in 2008.

In 2008, NMFS personnel did not PIT tag wild fish from Cape Horn and Herd Creeks because no collection permits were issued for these streams by the Idaho Department of Fish and Game (IDFG).

Interrogation at Instream PIT-Tag Monitors

Until recently, opportunities to monitor migrating PIT-tagged wild juvenile fish were limited to detection systems in a few instream or inriver traps (these traps required operators and were not passive monitoring sites), in the juvenile fish bypass systems at dams, or in the surface trawl detection system operated near the mouth of the Columbia River. In an effort to detect fish closer to tagging sites, we began development of instream PIT-tag monitoring systems in Valley Creek during 2002. We placed one monitoring system at each of two sites located 1.2 km apart. Development and improvement of these monitoring systems has continued since 2002, with details about the equipment used described in Achord et al. (2004; 2005; 2009). Briefly, both systems were set up to automatically interrogate, store, and transmit data to the PIT tag Information System (PTAGIS), a regional shared database operated by the Pacific States Marine Fisheries Commission (PTAGIS 1996).

In summer 2007, NMFS transitioned from using the 12 mm TX1411 ST PIT tag to the new 12 mm-TX1411 SST PIT tag for this study. The main reason for this change was the extended detection range (maximum about 43 cm) of the SST tag compared to the ST tag (maximum range about 20 cm). From 1 August 2007 through the first week of September 2007, a single instream ("hybrid") antenna at each site was operated as in previous years on Valley Creek. Starting the second week of September 2007, multiplex transceivers were installed at both Valley Creek monitoring sites, and two "pass-by" antennas were attached to the substrate at both monitoring sites. These were "speed-bump" type antennas constructed of 12.7 mm polyethylene (base-60 cm; height-17 cm; length-3 m) and placed end-to-end (with a gap in-between). One of the antennas at the upstream monitoring site failed after about 2 months of operation and was not replaced until mid-2008. In addition, as development of this system continued throughout 2007-2008; the monitoring systems operated intermittently.

In summer 2008, four specially designed rectangular antennas were staked to the substrate with duck-billed anchors at the upper monitoring site on Valley Creek (VC1). The new antennas were constructed from 10.2-cm (4 inch) diameter schedule-80 PVC pipe. Each antenna was rectangular (3 m long × 0.8 m wide) with two supporting cross-members. Two of these "pass by" antennas were also installed at the lower Valley Creek monitoring site (VC2), along with one "speed-bump" type antenna. Both monitoring systems operated throughout 2008-2009 with few problems.

With the development of PVC-pipe antennas and accompanying anchoring systems described above, we decided to install three "pass-by" antennas at both the upper and lower monitoring sites on lower Big Creek at Taylor Ranch (TAY-a and TAY-b, respectively). The antennas were scheduled to be installed in summer 2008 and to be left in place through spring 2009. An additional "speed-bump" type pass-by antenna was installed at the lower (TAY-b) monitoring site. The three PVC-pipe antennas installed at the lower site (TAY-b) were washed out during high flows in mid-May 2009; the remaining "speed-bump" pass-by type antenna flooded at this site about the same time. However, the duck-billed anchors held--we discovered that stronger straps were needed for attachments to the stakes. Ultimately, all three lost antennas were recovered intact. Despite these problems, both systems operated fairly well through mid-spring 2009.

Detection data from wild PIT-tagged yearling Chinook juveniles were collected from both instream detection systems at both Valley Creek and Big Creek from August 2008 through June 2009.

Juvenile Migrant Traps

Some fish PIT tagged as parr in natal rearing areas are subsequently collected at migrant traps (Figure 1). During fall 2008 and spring 2009, juvenile migrant fish traps were operated on the South Fork Salmon River at Knox Bridge, on Lake Creek, on the Secesh River near Chinook Campground and near the mouth, on Marsh Creek, on lower Big Creek at Taylor Ranch, and on the upper Salmon River near Sawtooth Hatchery. Also during spring 2009, juvenile migrant fish traps were operated on the lower Salmon River near Whitebird, Idaho, and on the Snake River at Lewiston, Idaho. Traps were operated by the Nez Perce Tribe and the IDFG.

Generally, fish at these traps were anesthetized, scanned for PIT tags, and then measured for length and weight. Some of these fish were also PIT tagged at the traps. Upon recovery from the anesthetic, all fish were released back to the streams or rivers.

Recaptures at Dams

While collecting and PIT tagging fish at the dams for various studies, NMFS and other personnel occasionally encounter wild fish that are already PIT tagged. In such cases, biological data are usually collected from these fish. To increase sample sizes for parr-to-smolt growth information on previously PIT-tagged wild fish, in 2009 we continued efforts begun in 2001 to utilize the PIT-tag separation-by-code system (Downing et al. 2001) at Little Goose Dam. The system was programmed to separate up to a maximum of 100 wild fish from each stream so that we could take length and weight measurements from a subsample of PIT-tagged study fish. All fish separated at the dam were handled using water-to-water transfers and other best handling practices. After handling, all tagged and untagged fish were returned to the river via bypass system flumes.

For wild smolts collected at Little Goose Dam, in addition to length and weight measurements, a Fulton-type condition factor (CF) was calculated as:

$$CF = \frac{weight\ (g)}{length\ (mm)^3} \times 10^5$$

Condition factors were calculated for these fish both at release (using release data associated with the PIT tag code) and recapture.

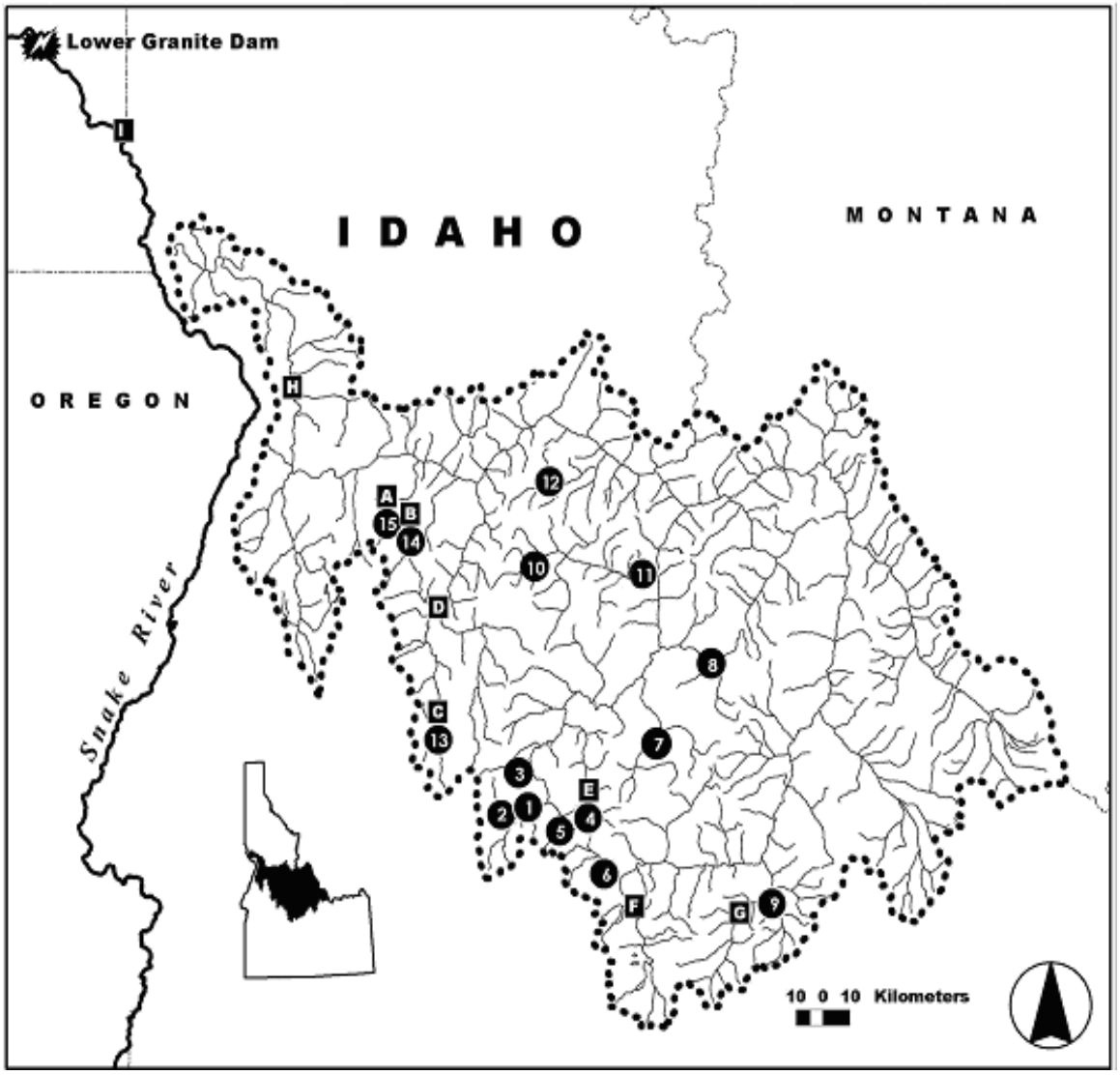

Figure 1. Wild spring/summer Chinook salmon parr were PIT tagged during 2008 in the following streams or sample areas:

1-Bear Valley Creek
2-Elk Creek
3-Sulphur Creek
4-Marsh Creek
5-(not sampled)
6-Valley Creek
7-Loon Creek
8-Camas Creek
9-(not sampled)
10-Big Creek (upper)
11-Big Creek (lower)(and **Trap**)
12-Chamberlain/W. F. Chamberlain Creeks
13-South Fork Salmon River
14-Secesh River
15-Lake Creek

Juvenile migrant fish traps shown above are as follows:

A-Lake Creek Trap
B-Secesh River Trap
C-South Fork Salmon River Trap
D-Lower Secesh River Trap
E-Marsh Creek Trap
F-Sawtooth Trap
G-East Fork Salmon River Trap
H-Salmon River Trap
I-Snake River Trap

Interrogation at Snake River and Lower Columbia River Dams

During spring and summer 2009, the surviving Chinook salmon we PIT tagged as parr in 2008 migrated volitionally downstream through hydroelectric dams on the Snake and Columbia Rivers. Of the eight lower Snake and Columbia River dams these smolts passed, the following seven were equipped with smolt collection and/or PIT-tag interrogation systems: Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dams on the Snake River, and McNary, John Day, and Bonneville Dams on the Columbia River.

At these seven dams, all smolts guided from turbine intakes into juvenile bypass systems were electronically monitored for PIT tags. The PIT-tag interrogation systems at dams were similar to those described by Prentice et al. (1990). Dates and times to the nearest second were automatically recorded on a computer as PIT-tagged fish passed each detector. Detection data were transferred to PTAGIS, a regional database, at designated intervals each day. Tagged fish were also monitored using a surface pair-trawl fitted with a PIT-tag detection antenna and operated in the upper Columbia River estuary ~150 km downstream from Bonneville Dam (Ledgerwood et al. 2004).

Migration Timing

We monitored within-season migration timing at Lower Granite Dam based on daily detection numbers (of all wild PIT-tagged Chinook salmon smolts) expanded relative to estimated daily detection probabilities. Detection probabilities were calculated using the methods of Sandford and Smith (2002) to provide an estimate of the number of PIT-tagged wild spring/summer Chinook salmon smolts that passed the dam each day. These daily totals were then summed to obtain a yearly survival estimate, which we compared to survival estimates from previous years.

Streams where wild parr were tagged for this study varied in temperature, elevation, mean flow, and population size. Therefore, to compare arrival timing at Lower Granite Dam between streams, we used an approach analogous to analysis of variance with multiple comparisons. The bootstrap method of Efron and Tibshirani (1993) was used to calculate estimates of the standard error for each migration timing statistic (e.g. arrival dates of the 10th, median, and 90th percentiles of the tagged population from each stream or sample area). Then, a "representative" estimate of variance for each statistic was calculated as the median of the standard errors (SEs) for fish from 17 stream populations. This method assumed that the timing of passage percentiles had similar distributions among streams. The Student-Newmann-Keuls (SNK) multiple comparison method was used to compare each statistic between streams ($\alpha = 0.05$; Petersen 1985).

We also examined the migration timing at Lower Granite Dam of individual populations over a period of years to determine similarities or differences between years and between populations. We chose populations with 8 or more years of timing data for these analyses. Comparisons of the 10th, 50th, and 90th percentile passage dates were made among 19 streams or sample areas using a two-factor analysis of variance (ANOVA). "Year" was considered a random factor and "stream" a fixed factor. Residuals were visually examined to assess normality. Treatment means were compared using Fisher's least significant difference procedure (Peterson 1985). Statistical significance was set at $\alpha = 0.05$.

Environmental Information

In 2008-2009, we collected hourly measurements of water temperature, dissolved oxygen, specific conductance, turbidity, water depth, and pH from the following locations: 1) Marsh Creek, 2) Valley Creek, 3) Sawtooth Hatchery in the upper Salmon River, 4) South Fork of the Salmon River (Knox Bridge), 5) Secesh River, and 6) lower Big Creek at Taylor Ranch. All monitoring systems except the system at Valley Creek were close to juvenile migrant fish traps. The water quality monitor at Valley Creek was located near our instream PIT-tag monitoring system (VC2).

In August 2008, we installed Level TROLL® 300 monitoring instruments (In-Situ Inc., Ft. Collins, CO), which measured hourly water temperature and depth in Bear Valley/Elk Creek, Sulphur Creek, Chamberlain Creek, West Fork Chamberlain Creek, and upper Big Creek. In October 2008, units were placed in Cape Horn Creek, Herd Creek, Loon Creek, Camas Creek, and Lake Creek.

RESULTS

Fish Collection and Tagging

From 29 July to 28 August 2008, we collected 10,775 wild Chinook salmon parr from 14 Idaho stream populations (Figure 1). These populations were located over a distance of about 40.5 stream kilometers and an area of approximately 360,262 m^2 (Table 1; Appendix Table 1). Of the fish collected, 9,718 were PIT tagged and released back into the streams, along with the remaining untagged live fish. Collected fish were not tagged if they had been previously PIT tagged or were too small, injured, or precocious, or if sufficient numbers of fish had already been tagged. Numbers of tagged fish released per stream or sample area ranged from 290 in Chamberlain Creek to 2,520 in Valley Creek (Table 1 and Appendix Tables 1 and 2a).

For all Chinook salmon parr collected in 2008, mean fork length was 67.2 mm and mean weight was 4.1 g. For Chinook salmon parr tagged and released after collection, mean fork length was 67.7 mm and mean weight was 4.1 g (Table 1; Appendix Table 1). Collection areas within streams were further delineated by recording Global Positioning System (GPS) coordinates using Universal Transverse Mercator (UTM) grid (Appendix Table 2b).

Other than Chinook salmon parr, sculpin were the most abundant fish observed during collection operations (Table 2). However, our records of non-target fish did not represent the total abundance of these species in the collection areas, since we targeted Chinook salmon, not other coincident species.

Mortality associated with collection and tagging procedures was low (Table 3; Appendix Table 3). Overall collection mortality was 1.3%, and overall tagging and 24-h delayed mortality was 0.05%. The overall observed mortality was 1.4%. In addition, one lost tag (0.01%) was observed during field work in 2008.

Table 1. Summary of collection, PIT tagging, and release of wild Chinook salmon parr with average fork lengths and weights, approximate distances, and estimated areas sampled in streams of Idaho during July and August 2008.

	Number of fish		Average length (mm)		Average weight (g)		Distance from collection area to stream mouth (km)	Estimated area sampled in streams (m^2)
Tagging location	Collected	Tagged and released	Collected	Tagged	Collected	Tagged		
Bear Valley Creek	637	498	65.0	65.3	3.7	3.7	9-10 & 13-13.5	17,200
Elk Creek	619	505	67.5	67.2	4.0	3.8	0-1.5	7,980
Marsh Creek	551	500	70.4	70.6	4.8	4.9	12-13	15,694
Sulphur Creek	514	503	70.6	70.5	4.7	4.6	5-8	24,403
Valley Creek	2,799	2,520	66.1	67.0	3.9	4.0	4-13 & 17-18	80,527
Loon Creek	557	500	64.5	65.0	3.8	3.9	29-33	30,009
Camas Creek	511	499	67.9	68.0	4.2	4.2	20-23	26,288
Big Creek (upper)	1,024	942	64.1	64.8	3.7	3.7	57-61 & 62-64	40,340
Big Creek (lower)	912	871	75.4	75.4	5.3	5.2	8-12 & 18-20	42,776
West Fork Chamberlain Cr	541	500	67.9	68.3	3.9	4.0	1-1.5	3,430
Chamberlain Creek	308	290	67.5	67.1	4.5	4.2	24-25	10,849
South Fork Salmon River	544	526	70.0	69.9	4.2	4.2	117-118	18,156
Secesh River	622	564	64.9	65.8	3.5	3.6	25-27	21,769
Lake Creek	636	500	61.8	62.9	3.3	3.4	1-3	20,841
Totals/averages	10,775	9,718	67.2	67.7	4.1	4.1	40.5	360,262

Table 2. Summary of species other than Chinook salmon parr observed during collection operations in Idaho in July and August 2008. Numbers of steelhead in parentheses (plus one mistaken cutthroat) were PIT tagged for the Idaho Department of Fish and Game.

Streams	Steelhead	Tagged Steelhead	Unidentified Fry	Brook trout	Cutthroat trout	Bull Trout
Bear Valley Creek	32	(0)	150	161	0	3
Elk Creek	21	(0)	9	82	0	0
Valley Creek	444	(0)	2,328	504	0	3
Camas Creek	230	(0)	380	0	3	3
Big Creek (upper)	265	(98)	610	280	(1)	13
Big Creek (lower)	159	(105)	641	0	0	2
Loon Creek	205	(0)	589	0	2	2
Marsh Creek	19	(0)	124	53	0	1
Sulphur Creek	118	(0)	152	0	0	
Secesh River	57	(0)	146	9	0	5
Lake Creek	54	(0)	39	30	0	26
South Fork Salmon River	230	(0)	138	3	0	0
Chamberlain Creek	75	(0)	49	0	0	1
West Fork Chamberlain Cr	31	(0)	2	0	0	7
Totals	1,940	(203)	5,357	1,122	6(1)	66

Streams	Sculpin	Dace	Sucker	Whitefish	Shiner
Bear Valley Creek	397	139	48	22	0
Elk Creek	75	5	59	464	0
Valley Creek	2,133	211	106	289	5
Camas Creek	0	0	0	34	0
Big Creek (upper)	2,372	0	0	0	0
Big Creek (lower)	594	485	154	27	0
Loon Creek	566	0	0	24	0
Marsh Creek	408	40	105	202	0
Sulphur Creek	1,353	3	1	4	0
Secesh River	601	38	0	5	0
Lake Creek	1,001	47	1	3	0
South Fork Salmon River	17	46	1	9	0
Chamberlain Creek	449	0	0	11	0
West Fork Chamberlain Cr	4	0	0	20	0
Totals	9,970	1,014	475	1,114	5

Table 3. Mortality percentages for wild Chinook salmon parr collected and PIT-tagged in Idaho in July and August 2008. There was one lost tag for the study.

	Mortality		
Tagging location	Collection	Tagging and 24-h	Overall
Bear Valley Creek	0.6	0.4	0.9
Elk Creek	0.2	0	0.2
Valley Creek	1.8	0	1.8
Camas Creek	0.8	0.2	1.0
Big Creek (upper)	1.5	0	1.5
Big Creek (lower)	2.2	0	2.2
Loon Creek	1.3	0	1.3
Marsh Creek	0.2	0	0.2
Chamberlain Creek	2.9	0.3	3.2
West Fork Chamberlain Creek	0	0	0
Sulphur Creek	1.0	0	1.0
South Fork Salmon River	2.2	0	2.2
Secesh River	1.3	0	1.3
Lake Creek	0.9	0	0.9
Averages	1.3	0.05	1.4

Detections at Instream PIT-Tag Monitors

Valley Creek Monitors

From 5 to 9 August 2008, 2,520 wild Chinook salmon parr were collected, PIT tagged, and released in natal rearing areas 3-16 km above the instream PIT-tag monitor in lower Valley Creek (VC1; Table 1). Between 5 August 2008 and 30 June 2009, the seven instream antennas at VC1 and VC2 had 591 unique detections of these fish (Figure 2). Median downstream travel time between VC1 and VC2 was approximately 17.5 h (range 16 min to 120.9 d) for the 142 fish detected at both monitoring sites. Of the 591 total unique detections, 418 (70.7%) occurred in late-summer/fall (August-October), 118 (20%) in winter (November-February), and 55 (9.3%) in spring (March-June; Figure 2).

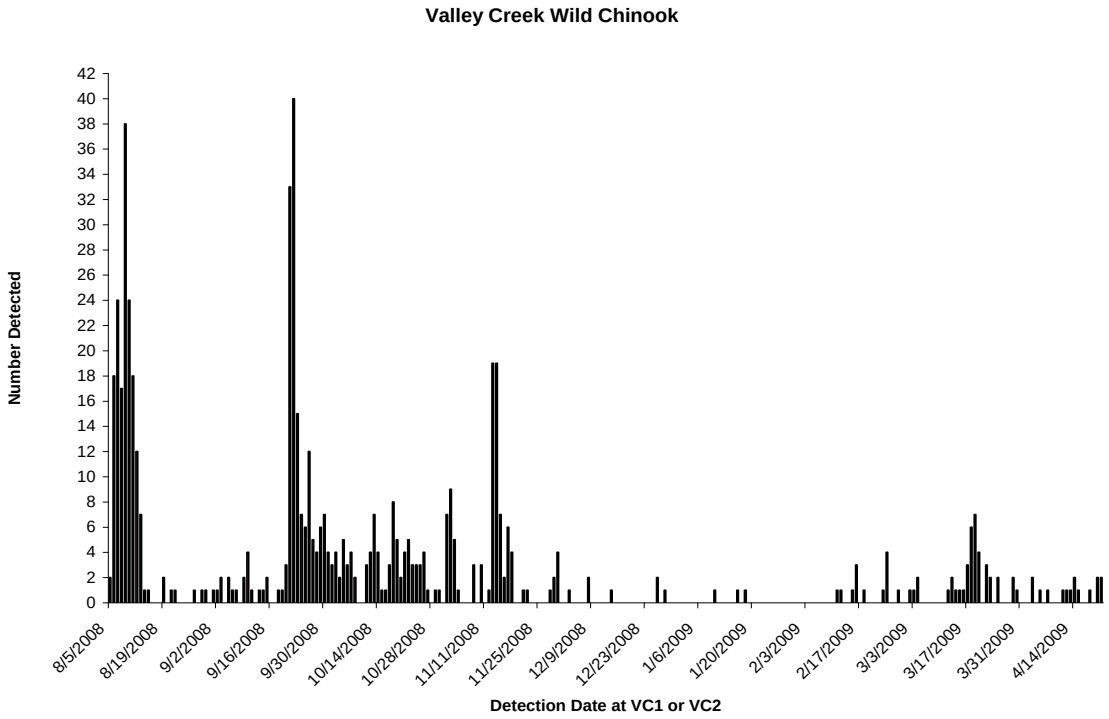

Figure 2. Detections of 591 PIT-tagged wild spring/summer Chinook salmon parr, pre-smolts, and smolts at the upper (VC1) and lower (VC2) Valley Creek instream PIT-tag monitoring systems from August 2008 through June 2009. A total of 2,520 Chinook salmon parr were PIT tagged and released in areas 3-16 km upstream from these antennas from 5 to 9 August 2008.

Based on detections at downstream dams, the overall efficiency of VC1 or VC2 for detecting these fish was 45.6%. Based on this efficiency, an estimated 34.8% of all summer-tagged parr survived to migrate out of this stream. For the 34.8% of parr that migrated out of Valley Creek, estimated survival from detection at a Valley Creek monitor to Lower Granite Dam was 27.3%. From August 2008 to June 2009, there was no apparent trend in fork length or median fork length (at tagging) for the 591 fish that were detected in lower Valley Creek (Figure 3).

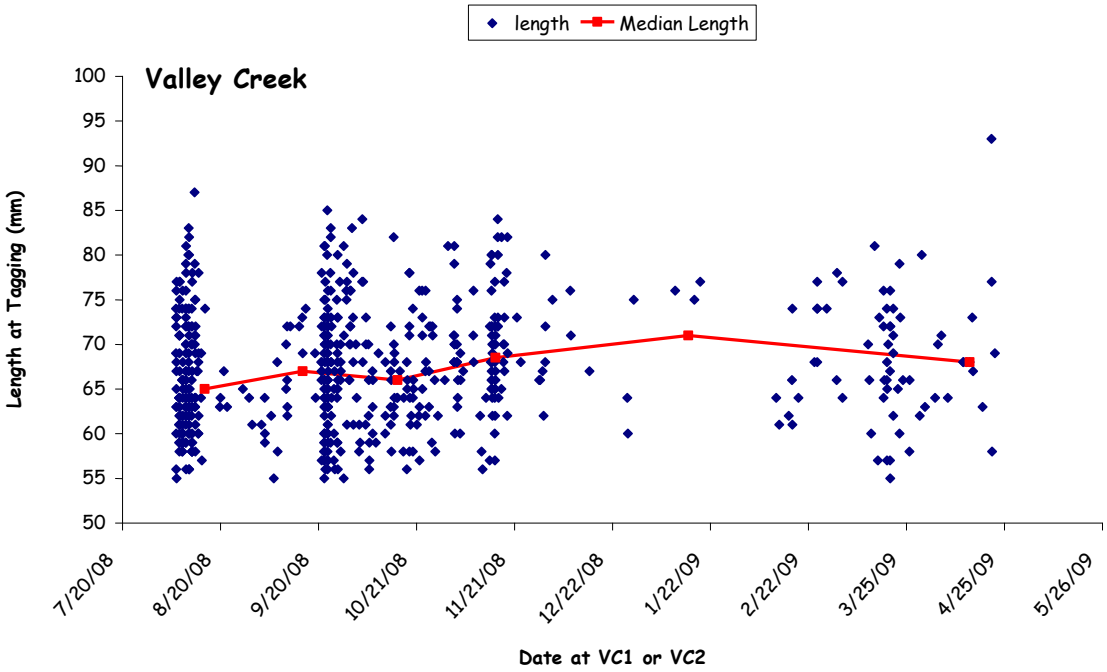

Figure 3. The fork lengths and median fork lengths of 591 summer-tagged parr that were detected at the upper and lower instream PIT-tag monitoring antennas in lower Valley Creek from August 2008 through June 2009.

Lower Big Creek Monitors at Taylor Ranch

From 17 to 20 August 2008, 871 wild Chinook salmon parr from lower Big Creek were collected, PIT tagged, and released in natal rearing areas 0-10 km above the instream PIT-tag monitors in lower Big Creek at Taylor Ranch (Table 1). Between 17 August 2008 and 30 June 2009, the 7 instream antennas at the upper (TAY-a) and lower (TAY-b) Taylor Ranch locations had 118 unique detections of these 871 fish (Figure 4). Median downstream travel time between monitoring sites for the 7 fish detected at both TAY-a and TAY-b ranged from 2 minutes to 187.3 d. Of the 118 unique detections, 68 (57.6%) occurred in late-summer/fall (August-October), 43 (36.4%) in winter (November-February), and 7 (5.9%) in spring (March-June; Figure 4).

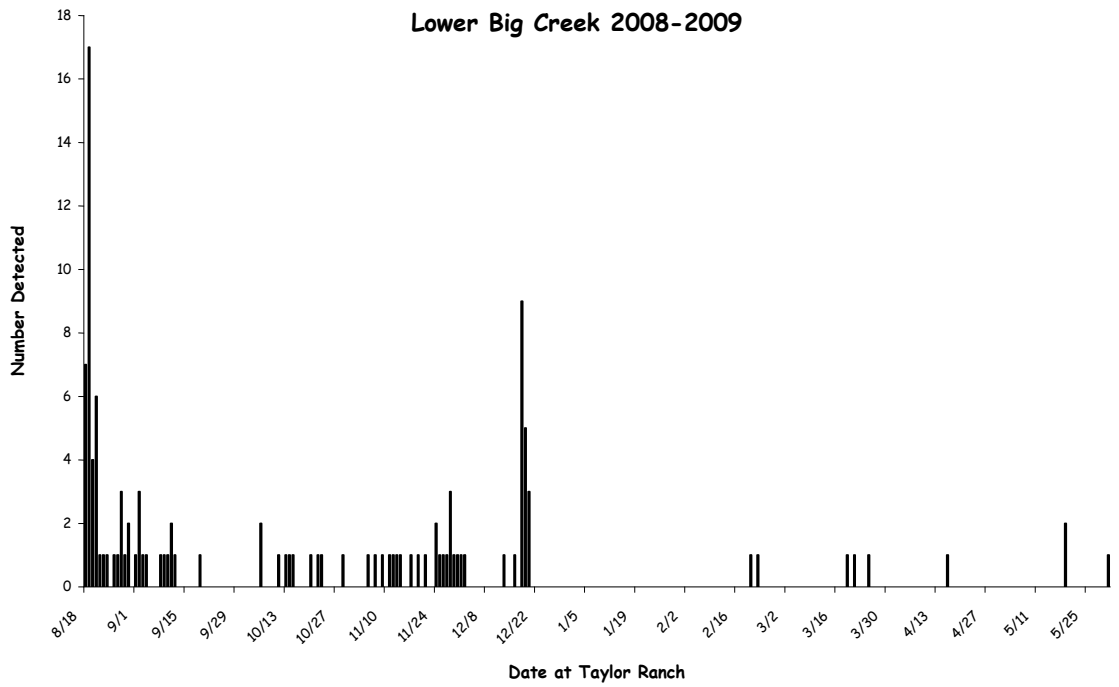

Figure 4. Detection dates of 118 wild spring/summer Chinook salmon parr, pre-smolts, and smolts in lower Big Creek on the upper (TAY-a) and lower (TAY-b) instream PIT-tag monitoring antennas at Taylor Ranch, August 2008-June 2009. A total of 871 Chinook salmon parr were PIT tagged and released in areas 0-10 km above these antennas during 17-20 August 2008.

Based on detections at downstream dams, the overall efficiency of the lower Big Creek upper (TAY-a) or lower (TAY-b) monitors for detecting these fish was 15.3%. Based on this efficiency, an estimated 88.5% of all summer-tagged parr from this stream (area) survived to migrate past these monitors, and their survival from that point to Lower Granite Dam was 28.9%.

From 12 to 14 August 2008, 942 wild Chinook salmon parr from upper Big Creek were collected, PIT tagged, and released in natal rearing areas 49-51 km upstream from the upper instream monitor in lower Big Creek (TAY-a; Table 1). Between September 2008 and June 2009, the 7 antennas at the upper (TAY-a) and lower (TAY-b) instream monitor locations on lower Big Creek had 49 unique detections of these fish (Figure 5). Downstream travel time between TAY-a and TAY-b sites for the 1 fish detected at both sites was 6 minutes. Of the 49 unique detections, 32 (65.3%) occurred in late-summer/fall; 10 (20.4%) in winter; and 7 (14.3%) in spring (Figure 5).

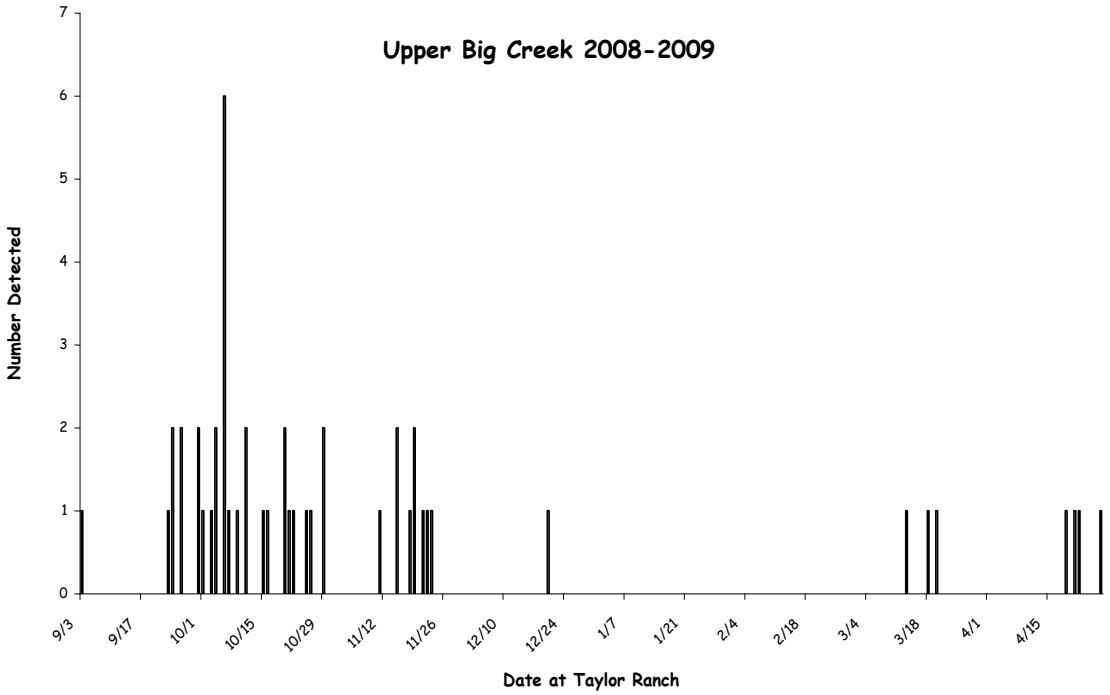

Figure 5. Detection dates of the 49 PIT-tagged wild spring/summer Chinook salmon parr, pre-smolts, and smolts released from upper Big Creek and detected at both the upper (TAY-a) and lower (TAY-b) instream monitoring antennas on lower Big Creek at Taylor Ranch, August 2008-June 2009. A total of 942 fish were released in areas 49-51 km above these antennas during 12-14 August 2008.

Based on detections at downstream dams, overall detection efficiency of the upper (TAY-a) or lower (TAY-b) monitors was 9.4%. Based on this efficiency, an estimated 55.2% of all summer-tagged parr survived to migrate out of this stream (area), and their survival from the monitoring sites to Lower Granite Dam was 24.6%.

The fork lengths and median fork lengths (at tagging) of the 167 detected fish (from upper and lower Big Creek) in lower Big Creek from August 2008 to June 2009, showed no apparent timing trend throughout this period (Figures 6 and 7).

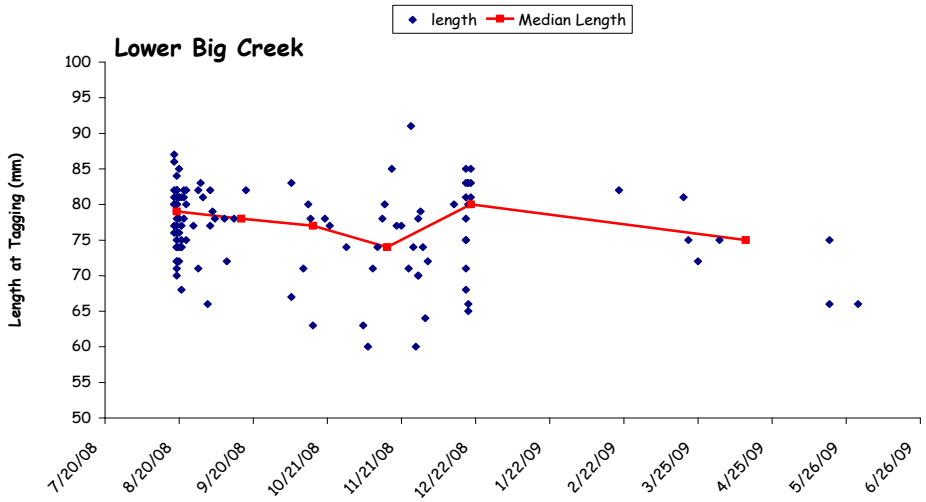

Figure 6. Length at tagging (FL) and median length of 118 summer-tagged parr from lower Big Creek that were detected at Taylor Ranch upper and lower instream monitor antennas, August 2008-June 2009.

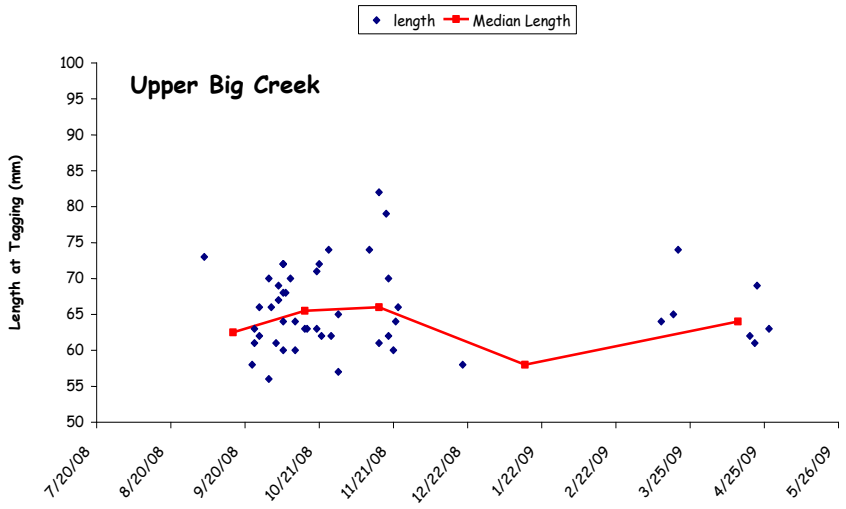

Figure 7. Length at tagging (FL) and median length of 49 summer-tagged parr from upper Big Creek that were detected at Taylor Ranch upper and lower instream monitor antennas, August 2008-June 2009.

Recaptures at Traps and Dams

Of the wild fish PIT-tagged in summer 2008, a total of 472 were recaptured at traps above Lower Granite Dam from summer or fall 2008 to spring 2009. A total of 764 fish were recaptured in the separation-by-code system at the Little Goose Dam juvenile fish facility (Table 4). Depending on the time span between tagging and recapture, fish were found with variable increases in weight and length.

Detections at Dams

Based on expanded detections (1,738 fish)[2] at Lower Granite Dam from 2 April to 25 June 2009, estimated survival from parr to smolt for Idaho fish averaged 17.9% (SE 0.7%; SE range, 1.0-4.0%; Table 5; Appendix Tables 5-18). An additional 839 first-time detections (unadjusted) were recorded at Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, and Bonneville Dams (Appendix Tables 5-17 and 19-24). By comparing all first-time detections at interrogation dams (1,603) to the expanded number of detections at Lower Granite Dam (1,738), we estimated that 7.8% of the wild fish from Idaho passed through the dams undetected.

For parr tagged in Idaho, average fork length at release was 67.7 mm (Table 1; Appendix Table 1). Among fish from this group that were detected the following spring at dams, average fork length at release was 69.5 mm; the difference in mean length between detected fish and all Idaho fish tagged was significant, although marginal ($P<0.01$). Also, fish that were larger at release tended to pass Lower Granite Dam significantly earlier than their smaller cohorts ($P<0.001$; Figure 8). Fish were grouped in 5-mm length bins to compare the length distribution of all Idaho fish vs. Idaho fish detected at the dams in spring. This comparison showed that length at release was significantly different for detected fish than for all fish released in all length bins except the 65-69 mm category ($P<0.05$; Figure 9).

In 2009, we found a significant difference in fork length at time of release between fish that migrated through Lower Granite Dam in April and May and those that passed the dam after May ($P< 0.0001$). Fish migrating through the dam in April and May were on average 5.3 mm larger when released than fish migrating after May. However, only 27 fish migrated through the dam after May. These data suggest that fish size influences migration timing or overwintering location.

[2] Due to rounding of numbers, the expanded detection numbers at Lower Granite Dam in Table 5 may vary slightly from expanded detection numbers in Appendix Tables 5-18.

Table 4. Recapture information on PIT-tagged wild spring/summer Chinook salmon from Idaho that were tagged in summer 2008 and recaptured by the separation-by-code system in the juvenile fish bypass system at Little Goose Dam in 2009 and at traps and other dams in the summer and fall of 2008 and spring and summer of 2009.

	Number	Length gain (mm)			Weight gain (g)			Condition Factor (avg)		Recapture interval (d)	
	recaptured	n	range	mean	n	range	mean	release	recapture	range	mean
Fish recaptured at Little Goose Dam (by stream)											
Bear Valley Creek	35	35	22-63	37.5	31	4.4-19	8.6	1.28	1.07	270-320	290
Elk Creek	42	42	20-62	42	40	4.5-20.3	9.7	1.24	1.02	262-309	282
Sulphur Creek	64	64	13-56	31.5	59	2.4-16.3	7.5	1.24	1.07	261-294	275
Marsh Creek	56	56	18-59	32.5	47	2.9-18.3	6.7	1.34	1.05	262-309	280
Valley Creek	99	99	15-61	38.2	65	2.9-15.5	8.6	1.26	1.03	258-294	278
Loon Creek	51	51	25-57	39.4	39	3.9-15.9	8.4	1.34	1.08	254-288	271
Camas Creek	39	39	23-58	38.3	39	4.5-17.3	8.7	1.27	1.04	256-289	276
Big Creek (upper)	78	78	18-58	38.4	65	3.4-17.3	8.6	1.28	1.08	260-303	283
Big Creek (lower)	99	99	16-55	30.4	40	2.3-16.5	7.0	1.20	1.00	245-268	258
South Fork Salmon River	49	49	18-49	34.2	27	3.5-13.3	7.7	1.26	1.03	234-284	260
WF Chamberlain Creek	37	37	23-52	37.7	13	4.4-12.5	9.0	1.18	1.02	250-300	268
Chamberlain Creek	41	41	27-49	37.8	15	5.5-12.2	8.0	1.26	1.02	245-281	259
Secesh River	45	44	14-51	36.9	11	4.5-11.4	7.8	1.26	1.03	232-282	254
Lake Creek	29	29	20-61	37.2	19	3.7-11.1	6.7	1.30	1.05	231-292	262
Totals or averages	764	763	13-63	36.1	510	2.3-20.3	8.1	1.27	1.04	231-320	271
Fish recaptured in traps											
Big Creek (Taylor Ranch)											
Upper Big Cr-fall	34	34	2-14	5.5	17	-1.8-2.1	0.2	1.31	1.10	15-84	44
Upper Big Cr-spring	3	3	9-22	16.3	2	1.1-3.7	2.4	1.19	1.07	217-263	241
Lower Big Cr-fall	34	34	-8-14	-0.2	11	-1-0.6	-0.3	1.26	1.19	1-81	9
Lake Creek											
Fall	130	130	-5-24	4.4	84	-1.2-3.8	0.1	1.30	1.10	1-67	28
Spring-summer	11	11	14-40	29.8	3	1.2-5.5	3.8	1.51	1.21	235-357	332

Table 4. Continued.

	Number recaptured	Length gain (mm)			Weight gain (g)			Condition Factor (avg)		Recapture interval (d)	
		n	range	mean	n	range	mean	release	recapture	range	mean
Fish recaptured in traps (continued)											
Secesh River											
Upper trap-fall	28	28	-1-10	4.2	18	-0.6-1.7	0.1	1.31	1.11	3-59	35
Upper trap-spr/sum	3	3	11-37	28.3	0	---	---	---	1.12	247-357	320
Lower trap-fall	25	25	-3-15	3.9	7	-1.6-0.3	-0.3	1.32	1.07	1-53	25
Marsh Creek											
Fall	102	102	-4-14	5.2	0	---	---	1.37	---	1-94	37
Spring/summer	2	2	21-42	31.5	0	---	---	---	---	247-378	313
South Fork Salmon River											
Fall	66	66	-3-11	2.7	23	-0.5-0.8	0.1	1.23	1.12	1-58	25
Spring	6	6	11-21	14.8	4	1.9-2.8	2.3	1.23	1.06	221-231	227
Salmon River-spring only	16	16	14-42	28.1	0	---	---	1.29	---	221-273	243
Snake River-spring only	12	12	25-45	34.5	0	---	---	1.27	---	241-292	259
Totals	472	472	---	---	169	---	---	---	---	---	---
Other collector dams											
Totals	0	0	---	---	0	---	---	---	---	---	---

Table 5. Summary of observed and expanded detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Lower Granite Dam in 2009. Table includes expanded numbers used for parr-to-smolt survival estimates and also includes standard error percentages (SE%). See Table 1 for numbers released.

	Lower Granite Dam Detections			
	Observed		Expanded	
Stream	N	%	N	% (SE)
Bear Valley Creek	36	7.2	83	16.7 (3)
Elk Creek	55	10.9	122	24.2 (3)
Marsh Creek	54	10.8	122	24.4 (3)
Sulphur Creek	59	11.7	139	27.6 (4)
Valley Creek	119	4.7	272	10.8 (1)
Loon Creek	65	13.0	145	29.0 (4)
Camas Creek	34	6.8	78	15.6 (3)
Big Creek (upper)	46	4.9	107	11.4 (2)
Big Creek (lower)	118	13.5	261	30.0 (3)
W Fork Chamberlain/Chamberlain Cr	71	9.0	165	20.9 (2)
South Fork Salmon River	33	6.3	76	14.4 (3)
Secesh River	50	8.9	112	19.8 (3)
Lake Creek	24	4.8	55	11.0 (2)
Totals or averages	764	7.9	1,738	17.9 (0.7)

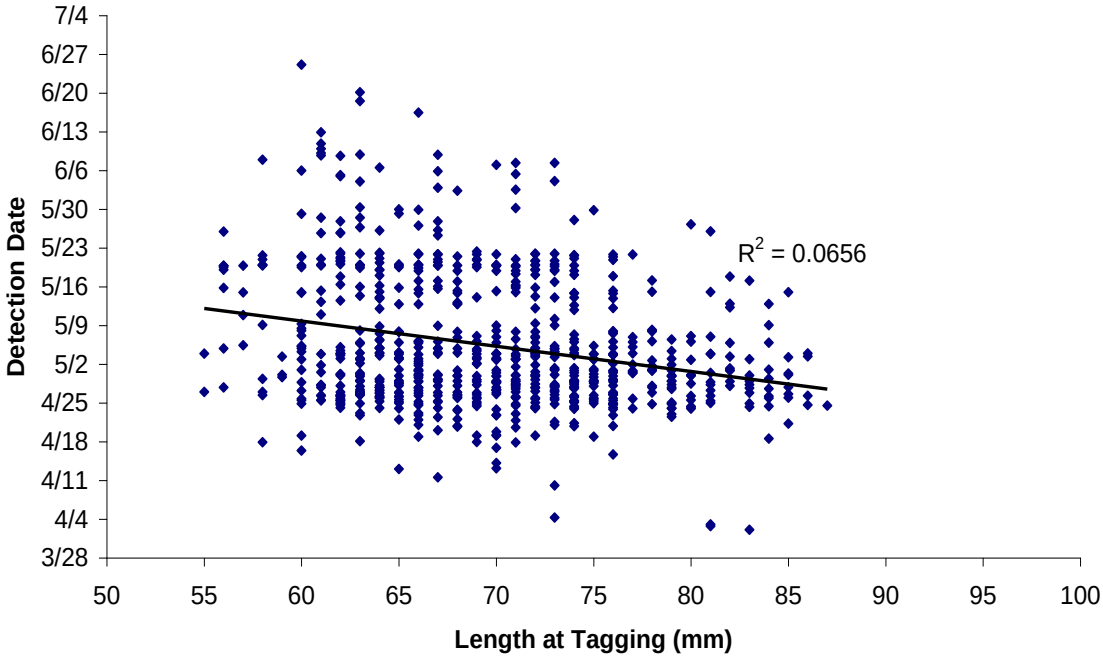

Figure 8. The relationship between fork length of parr at tagging (in 2008) to detection date at Lower Granite Dam in 2009.

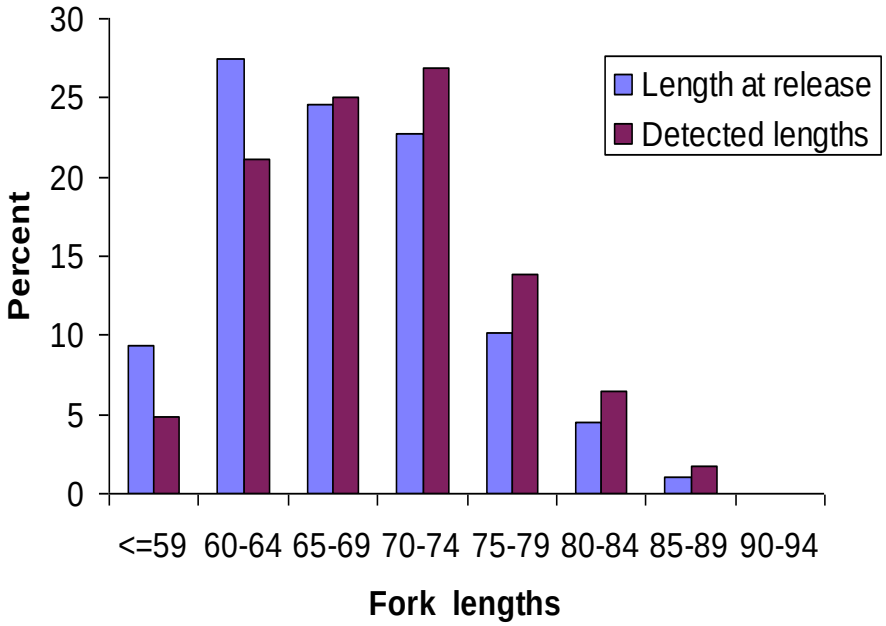

Figure 9. Percent by fork length increments (5 mm), of PIT-tagged wild spring/summer Chinook salmon parr released in Idaho streams in 2008 (n = 9,711) and percent of fish detected for these length increments at dams in spring and summer 2009 (n = 1,602).

In 2009, we estimated a 27.3% overall survival rate to Lower Granite Dam for Chinook salmon juveniles previously detected at the Valley Creek instream PIT-tag monitors. The overall parr-to-smolt estimated survival rate for fish from this stream was 10.8% (Table 5). Estimated survival rates for fish leaving Valley Creek in 2008-2009 were 21.8% for those leaving in late-summer/fall, 54.8% for fish leaving in winter, and 27.1% for fish leaving in spring.

In 2009, we estimated an overall survival rate from lower Big Creek to Lower Granite Dam of 28.9% for Chinook salmon juveniles previously detected at the instream PIT-tag monitors on lower Big Creek. Overall parr-to-smolt survival for fish from this stream (area) was estimated at 30.0% (Table 5). Estimated survival rates for fish leaving lower Big Creek 2008-2009 were 24.0% for fish leaving in late-summer/fall, 41.2% for fish leaving in winter, and 0% for fish leaving in spring. For Chinook salmon juveniles detected on the instream monitors at lower Big Creek, we estimated an overall survival rate from upper Big Creek to Lower Granite Dam of 24.6%. Overall parr-to-smolt survival for fish from this stream (area) was estimated at 11.4% (Table 5). Estimated survival rates for fish leaving upper Big Creek in 2008-2009 were 14.5% for those leaving in late-summer/fall, 0% for those leaving in winter, and 106% for those leaving in spring.

Migration Timing

Lower Granite Dam

Passage timing at Lower Granite Dam varied for fish from 17 Idaho and Oregon stream populations (Figure 10). In comparisons among 17 Idaho and Oregon stream populations, fish from the upper Imnaha and Lostine Rivers had a significantly earlier passage timing of the 10th percentile of the population than fish from all the other streams ($P < 0.05$; Figure 10; Appendix Table 4a-4b). For fish from upper Big Creek, the 10th percentile passed significantly later than that of fish from all other streams except Elk, Valley, Camas, and Loon Creeks and South Fork Salmon River ($P < 0.05$). Standard errors of these passage estimates ranged from 0.5 to 5.5 d (median 1.05 d). Overall, the 10th percentile passage dates for fish from 17 stream populations ranged from 13 to 26 April (Appendix Tables 4a-4b).

In comparisons of the 50th percentile passage date at Lower Granite Dam, fish from the Lostine and Secesh Rivers were significantly earlier than fish from all other streams except lower Big, Sulphur, Chamberlain/West Fork Chamberlain, Elk, Marsh, Bear Valley, Loon, and Lake Creeks and the South Fork Salmon River ($P < 0.05$). Fish from upper Big Creek arrived significantly later at the dam than fish from all other streams ($P < 0.05$). Standard errors of these passage estimates ranged from 0.5 to 3.2 d (median 1.35 d). The overall 50th percentile passage dates for fish from 17 stream populations ranged from 28 April to 19 May (Appendix Tables 4a-4b).

In terms of the 90th percentile passage date at the dam, fish from lower Big Creek were significantly earlier than fish from all other streams ($P<0.05$). Fish from Valley Creek were significantly later at the dam than fish from all other stream populations except Lake and upper Big Creek ($P<0.05$). Standard errors of these passage estimates ranged from 0.5 to 7.2 d (median 1.9 d). The overall 90th percentile passage dates for fish from all streams ranged from 7 May to 4 June (Appendix Tables 4a-4b).

For the number of days encompassing the middle 80th percentile passage (10th to 90th percentile), lower Big Creek fish had a significantly more condensed distribution (13 d) than fish from all other streams (23-40 d; $P<0.05$; Appendix Tables 4a-4b). Fish from Valley Creek displayed significantly more protracted timing at the dam than fish from all other stream populations except upper Imnaha and Lostine Rivers and Lake and Bear Valley Creeks (40 d vs. 13-31 d; $P<0.05$). Standard errors of these passage estimates range from 1.1 to 7.9 d (median 2.05 d).

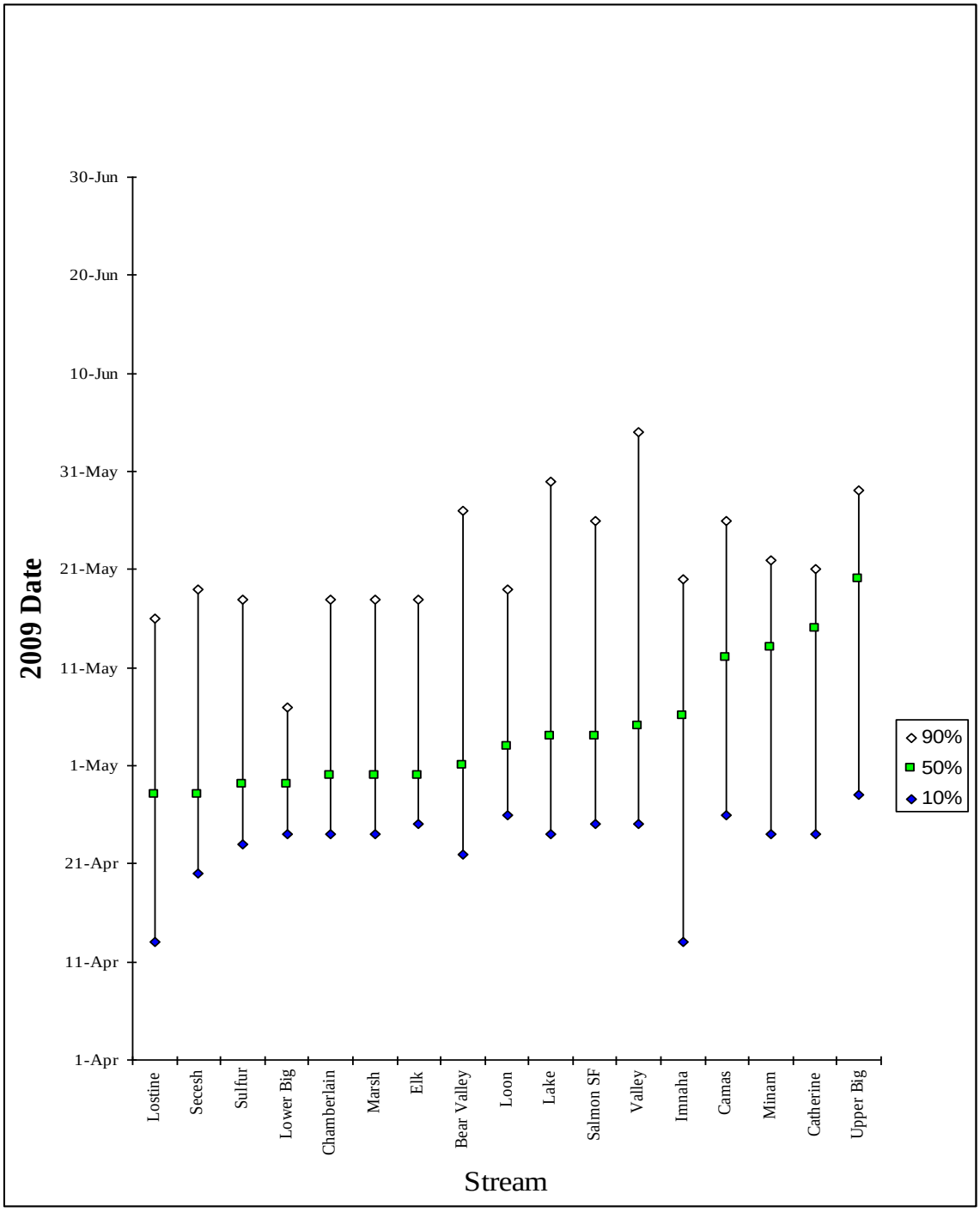

Figure 10. Estimated passage distribution by stream of origin for wild spring/summer Chinook salmon smolts at Lower Granite Dam, 2009. Idaho and Oregon streams are shown. Big Creek is divided into lower and upper portions and Chamberlain and W.F. Chamberlain Creeks were combined for these analyses. See Appendix Tables 5-18 for daily estimated passage numbers from Idaho streams at the dam.

Detection data at Lower Granite Dam for fish from streams with 8 or more years of data has shown clear variation among the 19 stream populations in arrival timing of the 10th, 50th, and 90th percentiles of these populations (Table 6). Secesh River fish had a significantly earlier timing at Lower Granite Dam for the 10th percentile passage than fish from all other streams except Lake Creek, and Lostine, Minam, and upper Imnaha Rivers ($P < 0.05$). Also, upper Big Creek fish had significantly later migration timing at the dam than fish from all other streams except Camas, Catherine, and Loon Creeks ($P < 0.05$). For the 50th percentile passage at the dam, Secesh River fish had significantly earlier arrival timing than fish from all other streams except lower Big and Herd Creeks ($P < 0.05$). Fish from upper Big Creek had significantly later timing at the dam than fish from all other streams except Catherine Creek ($P < 0.05$). For the 90th percentile passage at the dam, lower Big Creek fish had significantly earlier timing than fish from all other streams except Herd Creek ($P < 0.05$). Fish from upper Big and Valley Creeks and the South Fork Salmon River had significantly later timing at the dam than fish from all other streams except Bear Valley, Chamberlain/W. F. Chamberlain, Cape Horn, Lake, and Catherine Creeks, and the Secesh River ($P < 0.05$).

Comparison with Flows

We grouped first-time detections (expanded) at Lower Granite Dam of all Idaho and Oregon streams combined and compared their collective timing with river flows during the same periods (Figure 11; Appendix Table 18). Overall, passage at the dam during 2009 occurred between early April and late June, with the middle 80th percentile passing from 23 April to 20 May (Table 7). Peak passage dates occurred during moderate flows of 91.1 kcfs on 28 April and high flows of 139.8 kcfs on 19 May (Appendix Table 18).

Environmental Information

Environmental water quality factors varied by month and between locations (Appendix Tables 25-40), as did the percentage of fish collected and/or detected at adjacent traps or instream PIT-tag monitors (Appendix Figures 1-6). In 2007, Northwest Fisheries Science Center personnel completed the Water Quality Baseline Environmental Monitoring website for storage and dissemination of water quality data collected during this study since 1993 (NWFSC 2007). This website also has links to weather, climate, and stream flow data in the Salmon River basin.

Table 6. The 95% confidence interval (CI) and mean passage dates (10th, 50th, and 90th percentiles), with standard errors (SE) in days, at Lower Granite Dam for wild spring/summer Chinook salmon smolts from streams in Idaho and Oregon over all data years.

	Percentile passage dates at Lower Granite Dam (95% CI, mean, SE)			
Stream	10th (SE)	50th (SE)	90th (SE)	Data years
Secesh River	11-17 April, 14 April (1)	23-29 April, 26 April (1)	22 May-5 June, 29 May (3)	20
South Fork Salmon River	16-24 April, 20 April (2)	7-13 May, 10 May (1)	1 June-10 June, 6 June (2)	18
Catherine Creek	23-29 April, 26 April (1)	10-19 May, 14 May (2)	27 May-8 June, 2 June (3)	19
Imnaha River (upper)	14-19 April, 16 April (1)	29 April-5 May, 2 May (1)	17-25 May, 21 May (2)	17
Bear Valley Creek	18-25 April, 22 April (2)	4-10 May, 7 May (1)	25 May-3 June, 29 May (2)	18
Big Creek (upper)	25 April-4 May, 30 April (2)	13-23 May, 18 May (3)	28 May-15 June, 6 June (4)	15
Elk Creek	17-25 April, 21 April (2)	2-9 May, 5 May (2)	23 May-2 June, 28 May (2)	17
Valley Creek	21-29 April, 25 April (2)	9-17 May, 13 May (2)	30 May-10 June, 5 June (3)	18
Marsh Creek	17-23 April, 20 April (1)	1-8 May, 4 May (2)	19-28 May, 23 May (2)	15
Lake Creek	13-20 April, 16 April (2)	27 April-4 May, 30 April (2)	23 May-07 June, 31 May (3)	17
Lostine River	13-20 April, 16 April (2)	1-7 May, 4 May (1)	18-25 May, 21 May (2)	18
Sulphur Creek	16-27 April, 22 April (3)	1-15 May, 8 May (3)	20 May-3 June, 27 May (3)	11
Cape Horn Creek	19-30 April, 24 April (2)	6-17 May, 12 May (3)	23 May-7 June, 30 May (3)	12
Big (lower)/Rush Creeks	17-22 April, 19 April (1)	26 April-1 May, 29 April (1)	8-15 May, 12 May (2)	13
E. Fork Salmon River	15-24 April, 19 April (2)	25 April-7 May, 1 May (2)	13-23 May, 18 May (2)	7
Loon Creek	22 April-2 May, 27 April (2)	4-14 May, 9 May (2)	16-26 May , 21 May (2)	11
Herd Creek	17-24 April, 21 April (2)	26 April-4 May, 30 April (2)	11-18 May, 14 May (2)	11
Grand Ronde River (upper)	23 April-10 May, 1 May (3)	13 May-4 June, 24 May (4)	21 May-3 July, 12 June (8)	5
Imnaha River (lower)	5-20 April, 12 April (2)	14 April-5 May, 25 April (3)	2-15 May, 9 May (2)	4
Chamb/WF Chamberlain Ck.	16-24 April, 20 April (2)	28 April-8 May, 3 May (2)	14 May-10 June, 28 May (6)	11
Camas Creek	23-30 April, 27 April (2)	7-17 May, 12 May (2)	21-29 May, 25 May (2)	11
Minam River	13-21 April, 17 April (2)	1-8 May, 5 May (2)	18-25 May, 22 May (1)	11

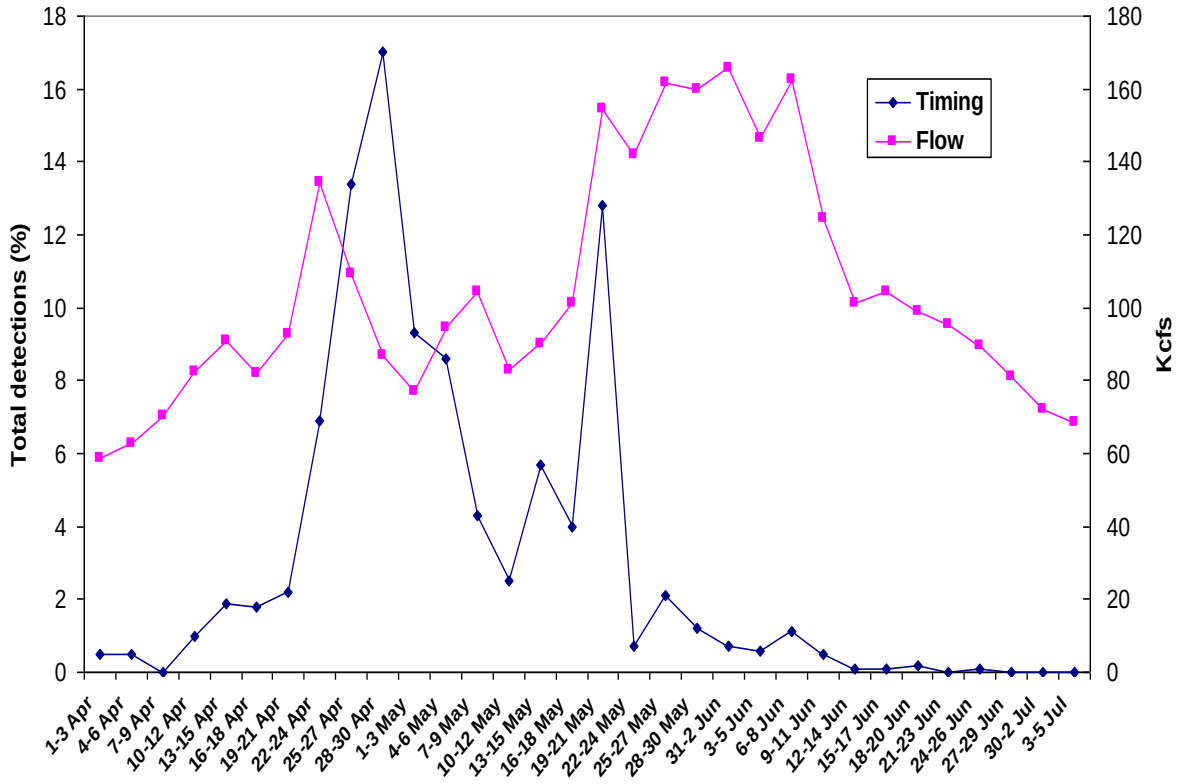

Figure 11. Overall migration timing of PIT-tagged wild spring/summer Chinook salmon smolts with associated river flows at Lower Granite Dam, 2009. Daily detections from Idaho and Oregon streams were pooled in 3-day intervals and expanded based on daily detection probability. River flows at the dam were averaged daily over the same periods.

Table 7. Accumulated and 2009 passage dates at Lower Granite Dam for combined populations of wild spring/summer Chinook salmon smolts PIT tagged the previous summers as parr in Idaho and Oregon streams.

	Passage periods at Lower Granite Dam			
Year	10%	50%	90%	Range
1989[a]	23 April	14 May	13 June	04 April-22 July
1990	19 April	07 May	07 June	05 April-18 July
1991	01 May	18 May	12 June	13 April-20 July
1992	15 April	02 May	27 May	05 April-27 July
1993	26 April	14 May	31 May	14 April-10 August
1994	22 April	08 May	01 June	13 April-4 Sept.
1995	17 April	09 May	04 June	8 April-22 Sept.
1996[a,b]	15 April	27 April	19 May	9 April-15 July
1997[a,b]	12 April	24 April	18 May	31 March-22 Sept.
1998[b]	11 April	02 May	23 May	31 March-7 Aug.
1999	20 April	03 May	28 May	27 March-8 July
2000	17 April	07 May	30 May	10 April-20 July
2001	26 April	09 May	27 May	6 April-7 July
2002	16 April	03 May	30 May	28 March-5 July
2003	18 April	11 May	29 May	31 March-4 July
2004	16 April	03 May	26 May	1 April-16 July
2005	25 April	07 May	24 May	4 April-20 June
2006	18 April	02 May	22 May	3 April-18 June
2007	15 April	30 April	14 May	5 April-18 June
2008	30 April	11 May	23 May	10 April-2 July
2009	**23 April**	**02 May**	**20 May**	**02 April-25 June**

a No fish were tagged from the Middle Fork of the Salmon River drainage for this migration year.

b This migration year represented by a much higher proportion of fish from Oregon streams than other years.

DISCUSSION

Mortality rates associated with collection and tagging in 2008 were comparable to those in earlier years (Achord et al. 1992; 1994-1998; 2000-2009). Instream PIT-tag monitoring systems used in Valley Creek have enabled us to calculate survival estimates and migration timing for wild Chinook salmon juveniles leaving this stream from late summer to the following spring each year from 2003-2004 to 2007-2008. However, prior to the 2008-2009 monitoring period, only 8-14% of the tagged juvenile Chinook salmon released were detected on instream monitors. The addition of a multiplex transceiver and additional antenna at each site in 2007 did not improve the precision of these survival estimates. However, during the 2007-2008 period, unforeseen problems related to the new SST tag resulted in intermittent operation of the instream monitoring sites. In 2008-2009, improved monitoring systems with 7 total antennas provided better survival estimates, with 23.5% of the tagged fish detected at the monitors.

Antennas for the instream monitors installed at Big Creek during 2006 proved inappropriate for this location. The "hybrid," or hinged rectangular antenna encased in PVC-pipe, has been used successfully in Valley Creek. However, in Big Creek, these antennas were largely destroyed by winter ice and floods. Therefore, in 2007, NMFS personnel began developing a new type of antenna. The "pass-by" antenna, with a design resembling a speed-bump, was evaluated in lower Big Creek in winter and spring 2007-2008. These antennas continued to operate through winter, but were dislodged during the very high flows in spring 2008.

We concluded that almost any type of antenna installed in Big Creek must be removed before high spring flows. However, in 2008, the newly developed "pass-by" PVC-pipe antennas, along with improved anchoring systems, allowed most of the antennas to remain secure in place during high spring flows in 2009. However, we discovered that although the anchoring systems for these antennas were adequate for the spring flows, stronger straps were needed for securing antennas to the substrate stakes. Although we were able to make survival estimates from detections at the Big Creek monitors in 2008-2009; we only detected 9.2% of the tagged fish. These low detection rates were responsible for the extreme variability observed when estimating survival rates for various groups of fish to Lower Granite Dam (0-106%). In the future, more precise survival estimates can be obtained by increasing the number of tagged fish released, improving antenna detection efficiency, and adding more antennas to the stream.

In 2008-2009, overall mean growth from the parr to smolt stage, as measured at Little Goose Dam (0.13 mm/d), was comparable to that in all previous years (0.13-0.16

mm/d; Achord et al. 2002-2009). Overall mean weight gain in 2008-2009 (0.030 g/d) was also comparable to that seen in previous years.

Annual parr-to-smolt survival estimates over the last 17 years have ranged from 8.2 to 24.4% for fish from the Idaho and Oregon streams combined, with an average annual survival rate of 16.4% (Figure 12). We measured the lowest parr-to-smolt survival estimates in 2004 and 2005, at 8.2 and 8.4%, respectively. These low estimates may have resulted from conditions with much higher parr density (see Figure 13 for Idaho streams). Returns of wild adults to the Snake River basin from 2001 to 2003 were more than an order of magnitude greater than those from 1994 to 1996, when we measured the highest parr-to-smolt survival (20.6 to 24.4%).

In 2009, fish that were larger at tagging tended to arrive earlier than smaller fish at Lower Granite Dam. In addition, we observed that wild fish detected at the dam early in the migration (April and May) had been significantly larger at release than fish migrating after May. We have consistently observed this tagging-length relationship with migration timing patterns at Lower Granite Dam over the two decades of the wild fish study. However, we have not observed a similar length-related migration timing pattern for parr, pre-smolts, and smolts detected moving out of lower Valley Creek during 2004-2009 (Achord et. al. 2006-2009; Figure 3) or out of Big Creek during 2008-2009

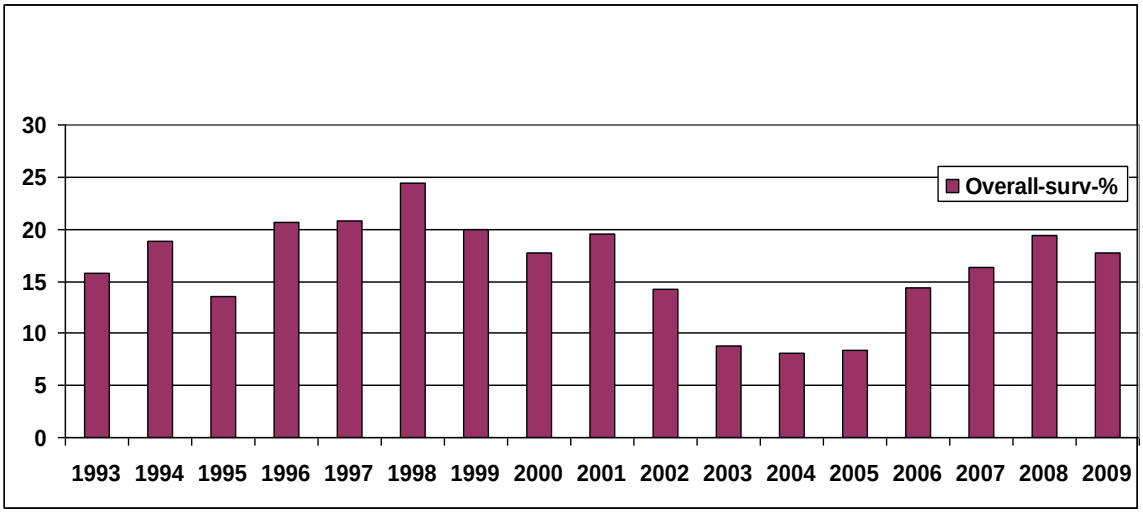

Figure 12. Overall estimated parr-to-smolt survival rates for wild spring/summer Chinook salmon from Idaho and Oregon streams to Lower Granite Dam from 1993 to 2009. Overall average standard error = 0.7% (yearly range 0.2-1.8%).

(Figures 6 and 7). This lack of any pattern between length and timing over an extended period in two locations shows that downstream movement of parr, pre-smolts, and smolts from natal rearing areas (from small streams to larger rivers) is not related to parr size at tagging. However, larger tagged fish probably initiate smoltification earlier than smaller tagged fish in spring, thus arriving at Lower Granite Dam earlier. Other external factors and life-history dynamics probably play roles that affect the migration timing of wild fish.

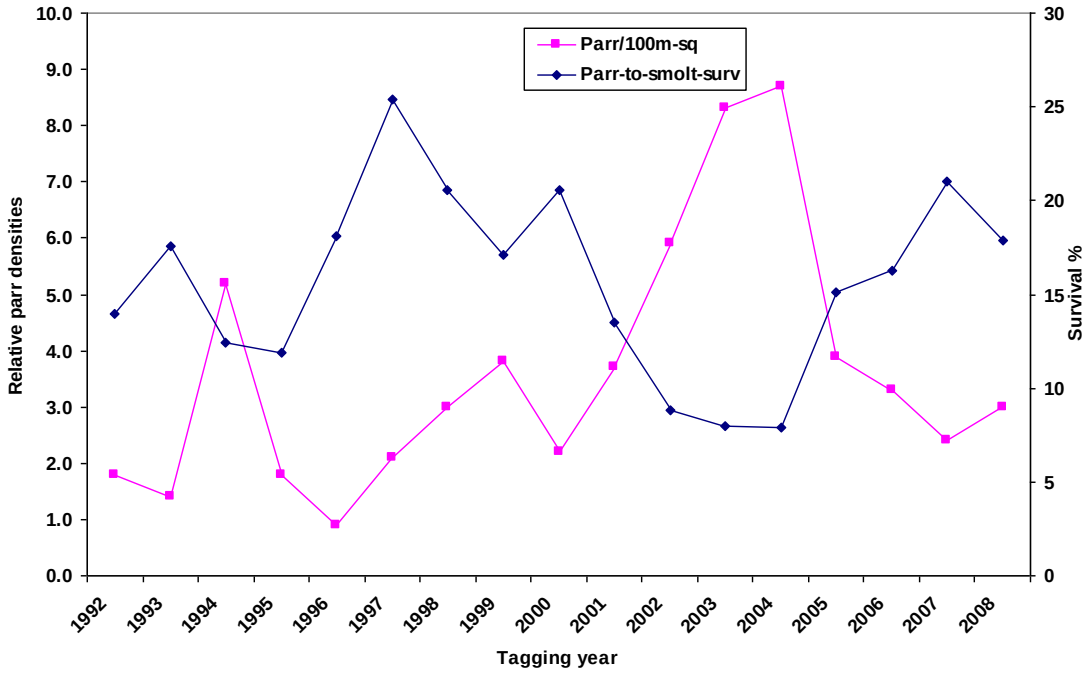

Figure 13. Annual average relative Chinook salmon parr densities (per 100 m^2) in areas sampled in all Idaho streams from 1992 to 2008 plotted against subsequent annual smolt survival estimate to Lower Granite Dam the following year.

In spring 2009, we observed that the 50th and 90th percentiles of the combined stream populations passed Lower Granite Dam in early and late-May, respectively.

In 2009, moderate to high flows occurred throughout the migration period after mid-April, and weather conditions that were cooler and wetter than normal prevailed in the Snake River basin after mid-May. As we have reported previously, Chinook salmon smolt passage timing at Lower Granite Dam for individual wild populations has been highly variable and usually protracted, with timing patterns for some populations ranging from early to late spring. Complex yearly interrelationships between flow and annual climatic conditions are primary factors contributing to passage timing. However, water temperatures in streams above the dam, turbidity, physiological development, variability

in stock behavior, fish size, and other yet unknown factors may all contribute substantially to wild smolt passage timing.

As additional environmental monitors, instream PIT-tag monitors, and traps are installed in study streams, we can more accurately monitor fry, parr, and smolt movements out of rearing areas and examine the relationships between these movements and environmental conditions within the streams. Mapped over time, this information, along with weather and climate data, may provide tools for the prediction of movement in different wild fish stocks. Such tools are vital to recovery planning for threatened or (ESA) endangered species of Pacific salmon.

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REFERENCES

Achord, S., G. A. Axel, E. E. Hockersmith, B. P. Sandford, M. B. Eppard, and G. M. Matthews. 2001a. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1999. Report to Bonneville Power Administration, Project 91-028, Contract 99-AI-19164. 87 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., G. A. Axel, E. E. Hockersmith, B. P. Sandford, M. B. Eppard, and G. M. Matthews. 2001b. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 2000. Report to Bonneville Power Administration, Project 91-028, Contract 99-AI-19164. 104 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., G. A. Axel, E. E. Hockersmith, B. P. Sandford, M. B. Eppard, and G. M. Matthews. 2002. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 2001. Report to Bonneville Power Administration, Project 91-028, Contract 00005619. 74 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., M. B. Eppard, E. E. Hockersmith, B. P. Sandford, G. A. Axel, and G. M. Matthews. 2000. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1998. Report to Bonneville Power Administration, Project 9102800, Contract DE-AI79-91BP18800. 82 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., M. B. Eppard, E. E. Hockersmith, B. P. Sandford, and G. M. Matthews. 1997. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1996. Report to Bonneville Power Administration, Project 91-028, Contract DE-AI79-91BP18800. 74 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., M. B. Eppard, E. E. Hockersmith, B. P. Sandford, and G. M. Matthews. 1998. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1997. Report to Bonneville Power Administration, Project 91028, Contract DE-AI79-91BP18800. 78 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., M. B. Eppard, B. P. Sandford, and G. M. Matthews. 1996a. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1995. Report to Bonneville Power Administration, Project 91-028, Contract DE-AI79-91BP18800. 179 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., J. R. Harmon, D. M. Marsh, B. P. Sandford, K. W. McIntyre, K. L. Thomas, N. N. Paasch, and G. M. Matthews. 1992. Research related to transportation of juvenile salmonids on the Columbia and Snake Rivers, 1991. Report to U.S. Army Corps of Engineers, Contract DACW68-84-H0034. 57 p. plus appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., E. E. Hockersmith, B. P. Sandford, R. A. McNatt, B. E. Feist, and G. M. Matthews. 2003. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 2002. Report to Bonneville Power Administration, Project 199102800, Contract 00005619. 94 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., J. M. Hodge, B. P. Sandford, E. E. Hockersmith, K. W. McIntyre, N. N. Paasch, and J. G. Williams. 2005. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 2004. Report to Bonneville Power Administration, Project 199102800, Contract 00005619. 94 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., D. J. Kamikawa, B. P. Sandford, and G. M. Matthews. 1995a. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1993. Report to Bonneville Power Administration, Project 91-028, Contract DE-AI79-91BP18800. 88 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., D. J. Kamikawa, B. P. Sandford, and G. M. Matthews. 1995b. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1994. Report to Bonneville Power Administration, Project 91-028, Contract DE-AI79-91BP18800. 100 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., G. M. Matthews, O. W. Johnson, and D. M. Marsh. 1996b. Use of Passive Integrated Transponder (PIT) tags to monitor migration timing of Snake River Chinook salmon smolts. N. Am. J. Fish. Manage. 16:302-313.

Achord, S., G. M. Matthews, D. M. Marsh, B. P. Sandford, and D. J. Kamikawa. 1994. Monitoring the migrations of wild Snake River spring and summer Chinook salmon smolts, 1992. Report to Bonneville Power Administration, Project 91-028, Contract DE-AI79-91BP18800. 73 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., R. A. McNatt, E. E. Hockersmith, B. P. Sandford, K. W. McIntyre, N. N. Paasch, J. G. Williams, and G. M. Matthews. 2004. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 2003. Report to Bonneville Power Administration, Project 199102800, Contract 00005619. 98 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., B. P. Sandford, E. E. Hockersmith, J. M. Hodge, K. W. McIntyre, N. N. Paasch, L. G. Crozier, and J. G. Williams. 2006. Monitoring the migrations of wild Snake River spring/summer Chinook salmon juveniles, 2004-2005. Report to Bonneville Power Administration, Project 199102800, Contract 00021961. 100 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., B. P. Sandford, E. E. Hockersmith, K. W. McIntyre, N. N. Paasch, and J. G. Williams. 2007a. Monitoring the migrations of wild Snake River spring/summer Chinook salmon juveniles, 2005-2006. Report to Bonneville Power Administration, Project 199102800, Contract 00021961. 102 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., B. P. Sandford, E. E. Hockersmith, M. G. Nesbit, N. D. Dumdei, J. J. Lamb, K. W. McIntyre, N. N. Paasch, and J. G. Williams. 2008. Monitoring the migrations of wild Snake River spring/summer Chinook salmon juveniles, 2006-2007. Report to Bonneville Power Administration, Project 199102800, Contract 00031849. 92 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., B. P. Sandford, E. E. Hockersmith, M. G. Nesbit, N. D. Dumdei, J. J. Lamb, K. W. McIntyre, N. N. Paasch, and J. G. Williams. 2009. Monitoring the migrations of wild Snake River spring/summer Chinook salmon juveniles, 2007-2008. Report to Bonneville Power Administration, Project 199102800, Contract 00031849. 90 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., R. W. Zabel, and B. P. Sandford. 2007b. Migration timing, growth, and estimated parr-to-smolt survival rates of wild Snake River spring/summer Chinook salmon from the Salmon River basin, Idaho, to the lower Snake River. Transactions of the American Fisheries Society 136:142-154.

Downing, S. L., E. F. Prentice, B. W. Peterson, E. P. Nunnallee, and B. F. Jonasson. 2001. Development and evaluation of passive integrated transponder tag technology, annual report: 1999 to 2000. Report to Bonneville Power Administration, project 83-319, contract 307-0001. (Available on the Internet at http://www.efw.bpa.gov/searchpublications/).

Efron, B., and R. J. Tibshirani. 1993. An introduction to the bootstrap. Chapman and Hall, Norwell, MA, 436 p.

Ledgerwood, R. D., B. A. Ryan, E. M. Dawley, E. P. Nunnallee, and J. W. Ferguson. 2004. A Surface Trawl to Detect Migrating Juvenile Salmonids Tagged with Passive Integrated Transponder tags. North American Journal of Fisheries Management 24:440-451.

Matthews, G. M., J. R. Harmon, S. Achord, O. W. Johnson, and L. A. Kubin. 1990. Evaluation of transportation of juvenile salmonids and related research on the Snake and Columbia Rivers, 1989. Report to U.S. Army Corp of Engineers, Contract DACW68-84-H0034. 59 p. plus Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle WA 98112-2097.)

NWFSC (Northwest Fisheries Science Center). 2007. The baseline water quality environmental monitoring program. Online database available at http://webapps.nwfsc.noaa.gov/WaterQuality/

Petersen, R. G. 1985. Design and analysis of experiments. Marcel Dekker, New York, 429 p.

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1990. PIT-tag monitoring systems for hydroelectric dams and fish hatcheries. Am. Fish. Soc. Symp. 7:323-334.

PTAGIS. The Columbia Basin PIT Tag Information System. http://www.ptagis.org

Sandford, B. P., and S. G. Smith. 2002. Estimation of smolt-to-adult return percentages for Snake River Basin anadromous salmonids, 1990-1997. J. Agric. Biol. Environ. Stat. 7(2):243-263.

APPENDIX

Data Tables and Figures

Appendix Table 1. Summary of numbers collected, tagged, released, and minimum, maximum, and mean lengths and weights of wild Chinook salmon parr, collected and PIT tagged in various Idaho streams, 2008.

			Collected				Released			
Number of fish			Length		Weight		Length		Weight	
Collected	Tagged	Released	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Bear Valley Creek										
637	500	498	45-88	65.0	1.4-9.4	3.7	55-88	65.3	2.1-9.4	3.7
Elk Creek										
619	505	505	51-139	67.5	1.7-38.8	4.0	55-83	67.2	2.1-7.1	3.8
West Fork Chamberlain Creek										
541	500	500	47-87	67.9	1.5-8.0	3.9	50-87	68.3	2.0-8.0	4.0
Valley Creek										
2,799	2,521	2520	45-128	66.1	1.0-22.3	3.9	55-93	67.0	2.0-15.8	3.7
Camas Creek										
511	500	499	53-84	67.9	1.8-8.8	4.2	55-84	68.0	1.9-8.8	4.2
Chamberlain Creek										
308	291	290	52-111	67.5	2.3-18.1	4.5	52-84	67.1	2.3-7.1	4.2
Big Creek (upper)										
1,024	942	942	49-115	64.1	2.0-20.1	3.7	55-106	64.8	2.0-15.8	3.7
Big Creek (lower)										
912	871	871	52-125	75.4	2.1-23.2	5.3	57-93	75.4	2.1-9.0	5.2
Loon Creek										
557	500	500	50-83	64.5	1.6-7.6	3.8	55-83	65.0	2.0-7.6	3.9
Marsh Creek										
551	500	500	53-88	70.4	1.8-10.1	4.8	57-88	70.6	2.1-10.1	4.9
Sulphur Creek										
514	503	503	54-132	70.6	1.6-27.9	4.7	56-92	70.5	2.0-12.1	4.6
Lake Creek										
636	500	500	44-108	61.8	1.2-14.7	3.3	54-88	62.9	2.0-10	3.4
South Fork Salmon River										
544	526	526	56-101	70.0	2.3-7.1	4.2	56-88	69.9	2.3-7.1	4.2
Secesh River										
622	564	564	49-112	64.7	1.6-15.6	3.5	55-82	65.7	1.9-6.8	3.6
Total or Mean										
10,775	9,723	9,718	44-139	67.2	1.0-27.9	4.1	50-106	67.7	1.9-15.8	4.1

Appendix Table 2a. Summary of tagging date, tagging start time (PST) and temperature (°C), release date and time (PST), and temperature, method of capture, distance (km) from the mouth of the stream to the release point, number released (2008), and number/percent of first-time detections (unadjusted) for each tag group at seven downstream dams and the PIT-tag trawl at the mouth of the Columbia River during 2009.

	Tagging			Capture	Release					Detection	
	Date	Time	(°C)	method	Date	Time	(°C)	rkm	N	N	(%)
Bear Valley Creek											
SA08211.BV1	7/29/08	--	11.5	SHOCK	7/30/08	0415	10.0	10	110	13	11.8
SA08211.BV2	7/29/08	--	12.0	SHOCK	7/29/08	0915	13.0	10	181	39	21.5
SA08212.BV1	7/30/08	--	11/0	SHOCK	7/31/08	0430	10.0	13	207	26	12.6
Elk Creek											
SA08213.EC1	7/31/08	--	10.0	BSEINE	8/01/08	0800	12.0	01	154	33	21.4
SA08213.EC2	7/31/08	--	10.0	BSEINE	7/31/08	1000	13.0	02	351	62	17.7
Marsh Creek											
SA08217.MC1	8/04/08	--	07.7	SHOCK	8/05/087	0600	8..0	12	131	28	21.4
SA08217.MC2	8/04/08	--	09.8	SHOCK	08/04/08	1100	13.0	13	369	72	19.5
Chamberlain Creek											
SA08234.CB1	8/21/08	--	10.0	SHOCK	8/22/08	0500	07.0	24	126	41	32.5
SA08234.CB2	8/21/08	--	10.4	SHOCK	8/21/08	1000	11.0	25	164	32	19.5
Sulpur Creek											
SA08218.SU1	8/05/08	--	09.0	SHOCK	8/06/08	0530	10.0	06	170	42	24.7
SA08218.SU2	8/05/08	--	11.0	SHOCK	8/06/08	0530	10.0	07	128	33	25.8
SA08219.SU1	8/06/08	--	10.0	SHOCK	8/06/08	0730	10.0	08	205	38	18.5
Valley Creek											
SA08218.VC1	8/05/08	--	10.5	SHOCK	8/06/08	0500	11.0	05	130	18	13.8
SA08218.VC2	8/05/08	--	12.0	SHOCK	8/05/08	1130	16.0	06	540	54	10.0
SA08219.VC1	8/06/08	--	13.0	SHOCK	8/06/08	1030	17.6	07	595	56	9.4
SA08220.VC1	8/07/08	--	12.8	SHOCK	8/07/08	1000	16.0	08	448	44	9.8
SA08221.VC1	8/08/08	--	10.0	SHOCK	8/08/08	1000	12.0	12	655	78	11.9
SA08222.VC1	8/09/08	--	10.0	SHOCK	8/09/08	0815	11.0	18	152	22	14.5

Appendix Table 2a. Continued.

	Tagging			Capture	Release					Detection	
	Date	Time	(°C)	method	Date	Time	(°C)	rkm	N	N	(%)
West Fork Chamberlain Creek											
SA08233.WC1	8/20/08	--	08.3	SHOCK	8/20/08	1000	09.5	01	500	73	14.6
Loon Creek											
SA08225.LN1	8/12/08	--	07.8	SHOCK	8/13/08	0500	08.9	30	113	30	26.5
SA08225.LN2	8/13/08	--	09.5	SHOCK	8/12/08	1030	12.0	31	214	51	23.8
SA08226.LN1	8/13/08	--	08.9	SHOCK	8/13/08	0915	10.4	31	173	37	21.4
Camas Creek											
SA08228.CA1	8/15/08	--	09.6	SHOCK	8/16/08	0500	09.7	21	111	20	18.0
SA08228.CA2	8/15/08	--	10.5	SHOCK	8/15/08	1100	14.0	22	223	30	13.5
SA08229.CA1	8/16/08	--	09.0	SHOCK	8/16/08	0800	09.8	23	165	29	17.6
Lake Creek											
SA08241.LC1	8/28/08	--	06.0	SHOCK	8/29/08	0500	07.0	02	102	13	12.7
SA08241.LC2	8/28/08	--	05.6	SHOCK	8/28/08	1045	09.0	02	398	43	10.8
Big Creek (upper)											
SA08225.BC1	8/12/08	--	07.0	SHOCK	8/13/08	0550	08.0	59	91	17	18.7
SA08225.BC2	8/12/08	--	08.0	SHOCK	8/13/08	0550	08.0	60	297	41	13.8
SA08226.BC1	8/13/08	--	08.0	SHOCK	8/13/08	1030	12.0	61	513	72	14.0
SA08227.BC1	8/14/08	--	08.0	SHOCK	8/14/08	0730	08.0	61	41	8	19.5
Big Creek (lower)											
SA08230.LB1	8/17/08	--	13.0	SHOCK	8/18/08	0600	13.0	10	214	68	31.8
SA08231.LB1	8/18/08	--	13.0	SHOCK	8/18/08	1050	15.0	11	357	95	26.6
SA08233.LB1	8/20/08	--	12.0	SHOCK	8/20/08	0945	12.5	19	300	59	19.7
South Fork Salmon River											
SA08238.SF1	8/25/08	--	11.7	SHOCK	8/26/08	0715	13.0	118	107	21	19.6
SA08238.SF2	8//25/08	--	11.0	SHOCK	8/25/08	1000	14.0	118	419	74	17.7
Secesh River											
SA08240.SE1	8/27/08	--	09.0	SHOCK	8/28/08	0415	07.5	26	100	16	16.0
SA08240.SE2	8/27/08	--	10.0	SHOCK	8/27/08	1100	10.0	27	464	75	16.2

Appendix Table 2b. Universal Transverse Mercator grid coordinates of Global Positioning System that identify sampling areas at the beginning and end of daily collections in streams for each collection crew in 2008.

Streams and dates	Section covered	UTM Start		UTM End	
		northing	easting	northing	easting
Bear Valley Creek					
7/29/2008	right bank	4920717	11T633214	4920708	11T632873
7/29/2008	left bank	4920731	11T632869	4920978	11T632747
7/29/2008	left bank	4920595	11T633178	4920949	11T632776
7/30/2008	right bank	4918959	11T629896	4919014	11T629762
7/30/2008	left bank	4919098	11T630256	4919054	11T630138
7/30/2008	right bank	4919087	11T630188	4919070	11T630082
Elk Creek					
7/31/2008	right bank	4918571	11T629148	4918675	11T628831
7/31/2008	left bank	4918571	11T629148	4918642	11T628837
7/31/2008	entire stream	4918814	11T629468	4918571	11T629148
Marsh Creek					
8/4/2008	left bank	4917105	11T646305	4916505	11T646764
8/4/2008	right bank	4917109	11T646295	4916396	11T646971
South Fork Salmon River					
8/25/2008	right bank	4944085	11T603572	4943305	11T603599
8/25/2008	left bank	4944085	11T603572	4943398	11T603625
Sulphur Creek					
8/5/2008	left bank	4933175	11T631138	4933676	11T630380
8/5/2008	right bank	4933175	11T631138	4933676	11T630380
8/6/2008	right bank	4933576	11T630380	4932410	11T629946
8/6/2008	left bank	4933576	11T630380	4932410	11T629946
Valley Creek					
8/5/2008	right bank	4899436	11T661316	4900035	11T660241
8/5/2008	left bank	4899450	11T661302	4900140	11T660062
8/6/2008	right bank	4900099	11T660017	4900736	11T659503
8/6/2008	left bank	4900167	11T660097	4900736	11T659503
8/7/2008	left bank	4900814	11T659556	4902089	11T659318
8/7/2008	right bank	4900819	11T659573	4902025	11T659255
8/8/2008	entire stream	4904136	11T658950	4904760	11T658820
8/8/2008	right bank	4903616	11T659072	4904760	11T658852
8/8/2008	left bank	4903611	11T659072	4904760	11T658852
8/9/2008	left bank	4906335	11T657725	4906470	11T657289
8/9/2008	right bank	4906335	11T657719	4906431	11T657465

Appendix Table 2b. Continued

Streams and dates	Section covered	UTM Start		UTM End	
		northing	easting	northing	easting
Chamberlain Creek					
8/21/2008	right bank	5026373	11T642254	5026004	11T641931
8/21/2008	left bank	5026373	11T642254	5026004	11T641931
Loon Creek					
8/12/2008	right bank	4941580	11T675180	4942250	11T674416
8/12/2008	left bank	4942250	11T675180	4941033	11T674058
8/13/2008	right bank	4942250	11T675180	4940961	11T673960
8/13/2008	entire stream	4941033	11T674058	4940178	11T673203
Camas Creek					
8/15/2008	left bank	4969041	11T695569	4967940	11T696859
8/15/2008	right bank	4969040	11T695662	4967939	11T696829
8/16/2008	left bank	4967940	11T696859	4967442	11T697169
8/16/2008	right bank	4967819	11T696949	4967434	11T697108
Big Creek-Lower					
8/17/2008	right bank	4996494	11T670258	4996661	11T668871
8/17/2008	left bank	4996494	11T670258	4996661	11T668871
8/18/2008	right bank	4996661	11T668871	4996910	11T667536
8/18/2008	left bank	4996494	11T670258	4996910	11T667536
8/20/2008	left bank	4998679	11T662754	4999337	11T661771
8/20/2008	right bank	4998679	11T662754	4999435	11T661815
Big Creek-Upper					
8/12/2008	left bank	4997257	11T632217	4996059	11T631450
8/12/2008	right bank	4997259	11T632217	4996065	11T631447
8/13/2008	left bank	4995558	11T631489		11T631327
8/13/2008	right bank	4996059	11T631433	4995519	11T631317
8/13/2008	left bank	4994406	11T630890	4994137	11T630726
8/13/2008	right bank	4994406	11T630890	4994137	11T630726
8/14/2008	left bank	4994088	11T630737	4993355	11T630736
8/14/2008	right bank	4994088	11T630737	4993355	11T630736
West Fork Chamberlain Creek					
8/20/2008	entire stream	5027473	11T641887	5027766	11T641520
Secesh River					
8/27/2008	left bank	5005867	11T592910	5007140	11T593536
8/27/2008	right bank	5007229	11T592909	5007229	11T593489
Lake Creek					
8/28/2008	right bank	5012319	11T586271	5013166	11T585570
8/28/2008	left bank	5012319	11T586271	5013321	11T585506

Appendix Table 3. Summary of observed total mortality for PIT-tagged wild Chinook salmon parr collected from Idaho streams during July and August 2008. Number rejected includes; fish too small to tag, precocious males, injured fish, fish collected for genetic evaluation, previously tagged fish, and in some cases extra collected fish. The portion of rejects that are precocious males are in parentheses. There was also one lost tag from Big Creek (upper).

Stream	Number collected	Number Tagged	Number Rejected	Percent Rejected (%)	Observed mortality			
					Collection and handling	Tagging delayed	Total	
							Num.	(%)
Bear Valley Creek	637	500	133	20.9	4	2	6	0.9
Elk Creek	619	505	113 (3)	18.3	1	0	1	0.2
Marsh Creek	551	500	50	9.1	1	0	1	0.2
Sulphur Creek	514	503	6 (3)	1.2	5	0	5	1.0
Valley Creek	2,799	2,521	229 (6)	8.2	49	1	50	1.8
Loon Creek	557	500	50	9.0	7	0	7	1.3
Camas Creek	511	500	7	1.4	4	1	5	1.0
Big Creek (upper)	1,024	942	67 (1)	6.5	15	0	15	1.5
Big Creek (lower)	912	871	21 (2)	2.3	20	0	20	2.2
West Fork Chamberlain Creek	541	500	41	7.6	0	0	0	0.0
Chamberlain Creek	308	291	8 (4)	2.6	9	1	10	3.2
South Fork Salmon River	544	526	6 (1)	1.1	12	0	12	2.2
Secesh River	622	564	50 (1)	8.0	8	0	8	1.3
Lake Creek	636	500	130 (3)	20.4	6	0	6	0.9
Totals or Average	10,775	9,723	911 (24)	8.5	141	5	146	1.4

Appendix Table 4a. Accumulated and 2009 passage dates at Lower Granite Dam for PIT-tagged wild spring/summer Chinook salmon smolts from streams in Idaho.

	Percentile passage dates at Lower Granite Dam			
Year	10th	50th	90th	Range
Bear Valley Creek				
1990[a]	19 April	05 May	31 May	11 April-18 July
1991	03 May	20 May	12 June	18 April-23 June
1992	15 April	02 May	24 May	07 April-28 June
1993	29 April	16 May	22 June	22 April-27 July
1994	22 April	06 May	29 May	16 April-15 July
1995	28 April	18 May	12 June	13 April-20 July
1996-1997[a]	---	---	---	---
1998	25 April	06 May	23 May	31 March-25 June
1999	23 April	03 May	07 June	20 April-21 June
2000	18 April	07 May	02 June	14 April-02 July
2001	08 May	16 May	28 May	26 April-17 June
2002	16 April	04 May	31 May	12 April-26 June
2003	14 April	05 May	28 May	12 April-14 June
2004	15 April	07 May	28 May	13 April-05 July
2005	20 April	05 May	23 May	20 April-10 June
2006	13 April	01 May	19 May	11 April-20 May
2007	18 April	03 May	13 May	08 April-24 May
2008	30 April	14 May	27 May	24 April-10 June
2009	22 April	01 May	27 May	18 April-16 June
Elk Creek				
1991	03 May	20 May	16 June	25 April-24 June
1992	11 April	30 April	28 May	05 April-17 July
1993	02 May	16 May	11 June	21 April-26 June
1994	23 April	04 May	21 May	18 April-09 July
1995	18 April	11 May	05 June	10 April-09 July
1990, 1996-1997[a]	---	---	---	---
1998	07 April	02 May	15 May	04 April-21 June
1999	21 April	03 May	27 May	01 April-08 July
2000	15 April	28 April	19 May	13 April-28 May
2001	30 April	11 May	27 May	30 April-27 May
2002	16 April	29 April	02 June	13 April-05 July
2003	20 April	06 May	29 May	31 March-30 May
2004	18 April	08 May	04 July	14 April-12 July
2005	27 April	11 May	29 May	18 April-12 June
2006	15 April	27 April	26 May	06 April-11 June
2007	16 April	02 May	14 May	14 April-31 May
2008	02 May	11 May	23 May	25 April-16 June
2009	25 April	30 April	18 May	19 April- 07 June
Sulphur Creek				
1990	18 April	30 April	31 May	11 April-27 June
1991[a]	---	---	---	---
1992	16 April	03 May	23 May	10 April-01 June
1993	28 April	16 May	12 June	24 April-28 June
1994[a]	---	---	---	---
1995	02 May	23 May	09 June	11 April-09 July

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Sulphur Creek(Continued)				
1996-1999[a]	---	---	---	---
2000	15 April	07 May	24 May	12 April-30 May
2001-2002, 2007[a]	---	---	---	---
2003	02 May	25 May	08 May	22 April-24 June
2004	10 April	25 April	11 May	02 April-24 May
2005	01 May	07 May	22 May	22 April-05 June
2006	11 April	28 April	17 May	11 April- 17 May
2008	03 May	12 May	02 June	27 April-04 June
2009	22 April	29 April	18 May	02 April-21 May
Cape Horn Creek				
1990, 1996-1998[a]	---	---	---	---
1991	24 April	16 May	28 May	19 April-06 June
1992	12 April	28 April	30 May	10 April-01 June
1993	08 May	19 May	26 June	05 May-01 July
1994[a]	---	---	---	---
1995	29 April	14 May	19 June	14 April-28 July
1999	29 April	22 May	29 May	25 April-12 June
2000	01 May	24 May	01 June	20 April-09 July
2001-2002, 2009[a]	---	---	---	---
2003	21 April	17 May	01 June	15 April-18 June
2004	15 April	04 May	24 May	14 April-28 May
2005	29 April	09 May	24 May	11 April-29 May
2006	23 April	30 April	14 June	22 April-14 June
2007	13 April	06 May	19 May	09 April-20 May
2008	03 May	18 May	23 May	25 April-03 June
Camas Creek				
1993	03 May	16 May	27 May	24 April-24 June
1994	30 April	15 May	26 May	24 April-11 July
1995	27 April	12 May	05 June	17 April-11 June
1996[a]	---	---	---	---
1997-1999[a]	---	---	---	---
2000	26 April	25 May	02 June	13 April-24 June
2001-2002[a]	---	---	---	---
2003	02 May	24 May	30 May	26 April-06 June
2004	18 April	08 May	24 May	16 April-04 June
2005	29 April	07 May	28 May	12 April-19 June
2006	20 April	30 April	17 May	20 April-03 June
2007	23 April	06 May	16 May	19 April-19 May
2008	05 May	14 May	21 May	27 April-31 May
2009	25 April	08 May	22 May	25 April-05 June
Marsh Creek				
1990	17 April	29 April	31 May	09 April-01 July
1991	26 April	20 May	09 June	17 April-18 June
1992	17 April	07 May	02 June	10 April-13 July
1993	29 April	15 May	27 May	24 April-10 August
1994	23 April	04 May	18 May	16 April-08 August
1995	17 April	09 May	24 May	11 April-08 July

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Marsh Creek (continued)				
1996-1998[a]	---	---	---	---
1999	21 April	01 May	25 May	11 April-13 June
2000	21 April	28 April	27 May	14 April-16 June
2001[a]	---	---	---	---
2002	18 April	04 May	23 May	14 April-26 May
2003	14 April	05 May	29 May	03 April-09 June
2004	16 April	28 April	10 May	03 April-30 May
2005	27 April	06 May	18 May	22 April-04 June
2006	12 April	30 April	18 May	11 April-03 June
2007[a]	---	---	---	---
2008	29 April	07 May	18 May	24 April-20 May
2009	23 April	30 April	18 May	20 April-22 May
Valley Creek				
1989	24 April	14 May	12 June	09 April-17 June
1990	16 April	08 May	05 June	12 April-29 June
1991	11 May	20 May	20 June	21 April-13 July
1992	15 April	30 April	27 May	13 April-04 June
1993	30 April	16 May	02 June	24 April-06 June
1994	24 April	04 May	03 June	22 April-09 June
1995	04 May	02 June	08 July	22 April-18 July
1996-1998[a]	---	---	---	---
1999	24 April	13 May	12 June	19 April-01 July
2000	20 April	12 May	29 May	13 April-14 July
2001	10 May	19 May	01 June	28 April-03 July
2002	24 April	20 May	03 June	19 April-19 June
2003	14 April	17 May	28 May	01 April-31 May
2004	25 April	11 May	26 May	04 April-16 June
2005	27 April	15 May	08 June	23 April-20 June
2006	30 April	24 May	15 June	16 April-17 June
2007	20 April	03 May	20 May	13 April-24 May
2008	28 April	11 May	26 May	21 April-06 June
2009	24 April	04 May	04 June	10 April-18 June
Loon Creek				
1993	05 May	12 May	17 May	03 May-5 June
1994	29 April	10 May	24 May	22 April-07 June
1995	23 April	11 May	28 May	13 April-07 June
1996-1998[a]	---	---	---	---
1999	30 April	18 May	27 May	22 April-16 June
2000	22 April	08 May	24 May	14 April-01 June
2001-2002, 2007[a]	---	---	---	---
2003	30 April	17 May	28 May	21 April-30 May
2004	23 April	05 May	15 May	15 April-26 May
2005	04 May	10 May	24 May	20 April-03 June
2006	20 April	02 May	19 May	10 April- 21 May
2008	07 May	17 May	26 May	28 April-29 May
2009	24 April	30 April	19 May	16 April-21 May

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
East Fork Salmon River—discontinued-see previous reports				
Herd Creek				
1992	14 April	20 April	10 May	13 April-18 May
1993	26 April	30 April	18 May	26 April-31 May
1994[b]	---	---	---	---
1995	18 April	03 May	14 May	11 April-28 May
1996-1998[a]	---	---	---	---
1999	20 April	29 April	10 May	30 March-20 May
2000	16 April	25 April	18 May	14 April-19 May
2001	30 April	04 May	14 May	28 April-07 June
2002[b]	---	---	---	---
2003	16 April	03 May	26 May	06 April-29 May
2004	16 April	30 April	10 May	12 April-21 June
2005	27 April	07 May	22 May	20 April-13 June
2006	16 April	25 April	06 May	10 April-16 May
2007[b]	---	---	---	---
2008	29 April	10 May	19 May	24 April-23 May
2009[a]	---	---	---	---
South Fork Salmon River				
1989	25 April	13 May	14 June	16 April-20 June
1990[a]	---	---	---	---
1991	20 April	16 May	10 June	17 April-13 July
1992	14 April	29 April	27 May	07 April-27 July
1993	29 April	16 May	02 June	26 April-28 June
1994	27 April	15 May	28 June	22 April-09 July
1995	20 April	10 May	10 June	13 April-13 July
1996	19 April	15 May	09 June	19 April-03 July
1997	13 April	28 April	12 June	07 April-15 June
1998	25 April	12 May	15 June	02 April-07 August
1999	31 March	04 May	01 June	27 March-11 June
2000	20 April	18 May	31 May	12 April-20 July
2001	29 April	14 May	01 June	26 April-07 July
2002	15 April	03 May	24 May	11 April-09 June
2003	19 April	16 May	03 June	19 April-12 June
2004	16 April	10 May	02 June	08 April-19 June
2005	28 April	12 May	30 May	22 April-19 June
2006	28 April	11 May	16 June	27 April-18 June
2007-2008[a]	---	---	---	---
2009	24 April	03 May	26 May	02 April-30 May
Big Creek (upper)				
1990	27 April	30 May	22 June	17 April-18 July
1991	18 May	10 June	26 June	26 April-01 July
1992	22 April	08 May	03 June	15 April-26 June
1993	08 May	18 May	26 May	26 April-15 June
1994	03 May	19 May	19 July	25 April-30 August
1995	05 May	23 May	09 June	02 May-26 June

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Big Creek (upper) Continued.				
1996-1998[a]	---	---	---	---
1999	28 April	14 May	03 June	25 April-19 June
2000	30 April	27 May	14 June	15 April-29 June
2001-2002[a]	---	---	---	---
2003	06 May	25 May	01 June	01 May-21 June
2004	18 April	12 May	05 June	15 April-17 June
2005	27 April	07 May	23 May	20 April-07 June
2006	26 April	08 May	25 May	19 April-10 June
2007	19 April	06 May	20 May	15 April-18 June
2008	06 May	20 May	23 May	25 April-05 June
2009	26 April	19 May	28 May	22 April-07 June
Big (lower)/Rush Creeks				
1993	24 April	29 April	13 May	21 April-16 May
1994	23 April	29 April	11 May	21 April-15 June
1995	19 April	01 May	14 May	11 April-05 June
1996[a]	---	---	---	---
1997[a]	---	---	---	---
1998[a]	---	---	---	---
1999	19 April	28 April	23 May	04 April-30 May
2000	19 April	30 April	13 May	16 April-26 May
2001[a]	---	---	---	---
2002	15 April	25 April	07 May	12 April-22 May
2003	14 April	26 April	18 May	12 April-25 May
2004	15 April	23 April	04 May	06 April-15 May
2005[d]	22 April	02 May	09 May	06 April-15 May
2006[d]	11 April	22 April	03 May	10 April-22 May
2007[d]	18 April	27 April	06 May	06 April-12 May
2008[d]	29 April	12 May	20 May	23 April-20 May
2009[d]	24 April	28 April	07 May	03 April-21 May
West Fork Chamberlain Creek				
1992[c]	15 April	26 April	03 June	12 April-24 June
1993	28 April	15 May	23 June	23 April-22 July
1994[c]	24 April	01 May	05 July	24 April-04 September
1995[c]	16 April	09 May	20 June	12 April-22 September
1996-1997[a]	---	---	---	---
1998[a]	---	---	---	---
1999-2001[a]	---	---	---	---
2002	26 April	04 May	20 May	18 April-29 May
2003[c]	23 April	20 May	26 May	21 April-26 May
2004[c]	11 April	24 April	10 May	07 April-23 June
2005[c]	26 April	03 May	13 May	20 April-30 May
2006	15 April	01 May	08 May	14 April-19 May
2007[c]	17 April	02 May	11 May	17 April-24 May
2008[a]	---	---	---	---
2009[c]	24 April	29 April	18 May	13 April-25 June

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Secesh River				
1989	20 April	27 April	09 June	09 April-19 July
1990	14 April	22 April	07 June	10 April-13 July
1991	20 April	27 April	14 June	13 April-20 July
1992	13 April	29 April	04 June	05 April-03 July
1993	26 April	16 May	16 June	22 April-15 July
1994	22 April	26 April	11 July	21 April-07 August
1995	14 April	01 May	24 May	10 April-10 July
1996	14 April	25 April	29 May	12 April-15 July
1997	10 April	18 April	04 May	04 April-11 July
1998	08 April	24 April	28 May	03 April-06 July
1999	03 April	23 April	25 May	29 March-21 June
2000	13 April	23 April	04 June	12 April-11 July
2001	16 April	28 April	13 May	06 April-13 June
2002	13 April	21 April	17 May	11 April-01 July
2003	18 April	30 April	01 June	03 April-04 July
2004	04 April	27 April	28 May	01 April-13 June
2005	23 April	03 May	26 May	04 April-19 June
2006	13 April	24 April	23 May	08 April-08 June
2007	09 April	22 April	16 May	05 April-23 May
2008[a]	---	---	---	---
2009	19 April	28 April	17 May	11 April-02 June
Lake Creek				
1989	23 April	02 May	16 June	12 April-01 July
1990[a]	---	---	---	---
1991[a]	---	---	---	---
1992[a]	---	---	---	---
1993	23 April	09 May	22 June	22 April-25 June
1994	21 April	28 April	19 May	20 April-24 June
1995	17 April	10 May	10 June	14 April-20 July
1996	15 April	21 April	19 May	15 April-02 June
1997	11 April	25 April	02 July	07 April-22 September
1998	04 April	25 April	26 May	02 April-16 July
1999	20 April	26 April	27 May	08 April-20 June
2000	13 April	04 May	04 June	13 April-18 July
2001[a]	---	---	---	---
2002	16 April	29 April	03 June	13 April-03 June
2003	06 April	06 May	04 June	06 April-20 June
2004	14 April	25 April	28 May	09 April-16 June
2005	20 April	28 April	29 May	19 April-19 June
2006	17 April	28 April	19 May	17 April-19 May
2007	08 April	27 April	03 May	08 April-14 May
2008	30 April	07 May	23 May	25 April-24 May
2009	23 April	03 May	30 May	04 April-20 June

a No parr were tagged the summer prior to migration in these years.
b Insufficient numbers detected to estimate timing.
c Includes fish from Chamberlain Creek.
d No fish were tagged in Rush Creek for this migration year.

Appendix Table 4b. Accumulated and 2009 passage dates at Lower Granite Dam for PIT-tagged wild spring/summer Chinook salmon smolts from streams in Oregon.

	Percentile passage dates at Lower Granite Dam			
Year	10th	50th	90th	Range
Catherine Creek				
1991	01 May	14 May	08 June	17 April-23 June
1992	16 April	01 May	21 May	09 April-29 June
1993	06 May	18 May	05 June	29 April-26 June
1994	25 April	11 May	20 May	13 April-26 July
1995	01 May	19 May	09 June	26 April-02 July
1996[a]	19 April	13 May	29 May	14 April-14 June
1997	08 May	14 May	01 June	24 April-10 June
1998	28 April	21 May	28 May	24 April-04 June
1999	26 April	25 May	15 June	26 April-26 June
2000	30 April	08 May	23 May	12 April-06 June
2001	29 April	17 May	17 June	28 April-03 July
2002	24 April	10 May	18 June	15 April-01 July
2003	26 April	10 May	09 June	14 April-09 June
2004	22 April	15 May	11 June	15 April-25 June
2005	20 April	12 May	23 May	14 April-02 June
2006	28 April	16 May	30 May	26 April-06 June
2007	19 April	29 April	17 May	19 April-19 May
2008	06 May	07 June	02 July	30 April-02 July
2009	24 April	13 May	21 May	12 April-13 June
Grande Ronde River (upper)				
1989	12 May	06 June	19 June	27 April-22 July
1990[b]	---	---	---	---
1991[b]	---	---	---	---
1992[b]	---	---	---	---
1993	05 May	16 May	25 May	23 April-20 June
1994	28 April	23 May	07 July	23 April-29 August
1995	27 April	29 May	12 June	12 April-01 July
1996[c]	26 April	17 May	29 May	19 April-06 June
1997, 2008-2009[b]	---	---	---	---
Imnaha River (lower)				
1989	11 April	30 April	11 May	04 April-05 June
1990	10 April	18 April	09 May	05 April-27 May
1991	20 April	01 May	13 May	14 April-15 May
1992	10 April	21 April	03 May	06 April-21 May
1993-2009[b]	---	---	---	---
Imnaha River (upper)				
1993	24 April	14 May	28 May	15 April-23 June
1994	24 April	08 May	09 June	20 April-11 August
1995	13 April	02 May	03 June	10 April-07 July
1996	16 April	26 April	18 May	14 April-12 June
1997	11 April	19 April	11 May	03 April-02 June
1998	11 April	28 April	13 May	03 April-24 May
1999	22 April	08 May	26 May	17 April-03 June
2000	14 April	02 May	24 May	12 April-16 June

Appendix Table 4b. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Imnaha River (upper) (continued)				
2001	21 April	30 April	16 May	08 April-28 May
2002	16 April	04 May	17 May	15 April-31 May
2003	22 April	08 May	26 May	17 April-31 May
2004	19 April	04 May	22 May	18 April-8 June
2005	19 April	03 May	27 May	05 April-11 June
2006	12 April	29 April	15 May	03 April-04 June
2007	13 April	25 April	13 May	05 April-24 May
2008	17 April	06 May	22 May	14 April-01 June
2009	13 April	05 May	20 May	04 April-09 June
Lostine River				
1990[d]	---	---	---	---
1991	29 April	14 May	26 May	20 April-09 July
1992	16 April	30 April	11 May	12 April-02 June
1993	23 April	03 May	17 May	17 April-01 June
1994	22 April	30 April	16 May	19 April-07 June
1995	12 April	02 May	17 May	08 April-09 June
1996	23 April	15 May	07 June	17 April-19 June
1997	17 April	28 April	16 May	09 April-21 May
1998[b]	---	---	---	---
1999	30 March	09 May	27 May	29 March-29 May
2000	13 April	08 May	25 May	13 April-03 June
2001	25 April	09 May	22 May	10 April-12 June
2002	11 April	21 April	13 May	28 March-29 May
2003	13 April	08 May	26 May	11 April-03 June
2004	15 April	04 May	05 June	14 April-15 June
2005	16 April	29 April	26 May	05 April-18 June
2006	14 April	26 April	16 May	05 April-09 June
2007	14 April	03 May	15 May	05 April-21 May
2008	22 April	11 May	29 May	10 April-14 June
2009	13 April	28 April	15 May	02 April-21 May
Minam River				
1999	08 April	28 April	25 May	31 March-02 June
2000	15 April	03 May	22 May	10 April-29 May
2001	25 April	07 May	23 May	08 April-12 June
2002	17 April	03 May	20 May	16 April-31 May
2003	17 April	13 May	29 May	13 April-01 June
2004	15 April	28 April	28 May	08 April-31 May
2005	19 April	08 May	21 May	08 April-08 June
2006	13 April	08 May	20 May	11 April-06 June
2007	11 April	27 April	12 May	04 April-22 May
2008	23 April	08 May	21 May	17 April-11 June
2009	24 April	13 May	22 May	11 April-06 June

a Includes fish tagged from summer 1995 through spring 1996.
b No parr were tagged the summer prior to this migration year.
c All fish tagged at traps in fall or spring for this migration year.
d Insufficient numbers detected to estimate timing.

Appendix Table 5. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 498 wild Chinook salmon from Bear Valley Creek released 29-30 July 2008. Release sites were 629-633 km above Lower Granite Dam.

	Bear Valley Creek							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
18 Apr	1	2						
19 Apr	2	4						
22 Apr	1	2						
23 Apr	1	2						
24 Apr	2	4						
25 Apr	1	2						
26 Apr	3	6	2					
27 Apr	1	2	1					
28 Apr	1	2						
29 Apr	1	3	2					
30 Apr	3	9						
1 May	2	5	1					
3 May	3	7						
4 May	1	2			1			
6 May	2	4	1			1		
7 May				1				
8 May				1				
9 May						1		
10 May			1					
13 May			1					
14 May	1	2		1				
17 May			1					
18 May	1	2	1			1		
19 May	1	2						
20 May	2	5						
21 May	2	6	2				1	
22 May			1	1				
23 May			2					
24 May			2					
25 May			1					
26 May			5					
27 May	1	2	3	2				
28 May			1					
29 May				1				
01 Jun			1		1			
04 Jun								
05 Jun	1	2						
09 Jun	1	2						
10 Jun								
16 Jun	1	3						
Totals	36	83	29	7	2	3	1	0

Appendix Table 6. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 505 wild Chinook salmon from Elk Creek released 31 July 2008. Release sites were 634-636 km above Lower Granite Dam.

	Elk Creek							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
19 Apr	1	2						
20 Apr	1	2	1					
21 Apr	1	2						
25 Apr	5	10						
26 Apr	7	14						
27 Apr	6	13	1					
28 Apr	3	7						
29 Apr	1	3	1	1				
30 Apr	3	9						
01 May	2	5	2					
02 May	2	4	1					
03 May	5	11	2					
04 May	4	9	1					
05 May	1	2	1			2		
06 May			3			1		
07 May	1	2		1				
08 May	1	2	1	1		1		
09 May								
10 May						1		
11 May	1	3				1		
12 May	2	5				1		
13 May								
14 May	1	2						
15 May	1	2						
16 May						1		
17 May								
18 May	1	2				1		
19 May	2	4						
20 May	2	5	2			1		
21 May			1					
22 May			1					
23 May			1					
24 May			1	1				
25 May			2					
26 May			1	1				
27 May								
28 May								
31 May			1					
01 Jun								
03 Jun			1					
07 Jun	1	2						
Totals	55	122	25	5	0	10	0	0

Appendix Table 7. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 500 wild Chinook salmon from Marsh Creek released 04 August 2008. Release sites were 632-634 km above Lower Granite Dam.

	Marsh Creek							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
20 Apr	1	2						
21 Apr	1	2						
22 Apr	2	4						
23 Apr	1	2						
24 Apr	6	12	1					
25 Apr	2	4						
26 Apr	1	2						
27Apr	3	7	3					
28 Apr	4	9						
29 Apr	3	8	2	2				
30 Apr	4	12	1					
01 May	1	2	2	1				
02 May	1	2	1					
03 May	4	9	3	1				
04 May	3	7						
05 May	1	2	1		1			
06 May	2	4	1	1				
07 May	1	2	2	1				
08 May			1					
09 May			1			1		
10 May								
11 May			1					
12 May	2	5				1		
13 May								
14 May	1	2	2					
15 May	2	4						
17 May	2	4	1					
18 May	2	4						
19 May	1	2		1			1	
20 May			2			1		
21 May	2	6		1				
22 May	1	2						
23 May			1		1			
24 May				1				
25 May			2					
26 May			1					
27 May								
28 May				1				
30 May								
06 Jun			1					
Totals	54	122	30	10	2	3	1	0

Appendix Table 8. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 503 wild Chinook salmon from Sulphur Creek released 05-06 August 2008. Fish were released 604-607 km above Lower Granite Dam.

	Sulphur Creek							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
02 Apr	1	3						
17 Apr	1	2						
18 Apr	1	2						
21 Apr	1	2						
22 Apr	1	2						
23 Apr	2	4						
24 Apr	3	6	1					
25 Apr	2	4		1				
26 Apr			3					
27 Apr	2	4	3					
28 Apr	10	24	2					
29 Apr	7	18	1	1				
30 Apr	4	12	2	1				
01 May	3	7	2	1	1			
02 May	1	2						
03 May	3	7	2					
04 May	1	2	1					
05 May	1	2	4					
06 May			4			1		
07 May			1	1	1	1		
08 May	1	2	1		1			
09 May	2	5						
10 May				1				
11 May	1	3	1					
12 May	1	3						
13 May	1	2	1					
14 May								
15 May	1	2	1					1
16 May	2	4						
17 May						1		
18 May	1	2						
19 May	2	4						
20 May	1	2	1				1	
21 May	2	6		1				
22 May				1				
23 May			1					
24 May								
25 May			3		1			
26 May			2					
27 May								
29 May								
30 May								
31 May								
02 Jun								
03 Jun								
06 Jun								
08 Jun								
11 Jun								
18 Jun								
Totals	59	139	37	8	4	3	1	1

Appendix Table 9. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 2,520 wild Chinook salmon from Valley Creek released 05-09 August 2008. Release sites were 743-757 km above Lower Granite Dam.

	Valley Creek							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
10 Apr	1	3						
16 Apr	1	2						
17 Apr	2	5						
20 Apr				1				
21 Apr	1	2	1					
22 Apr	1	2						
23 Apr	1	2						
24 Apr	4	8			1			
25 Apr	4	8				1		
26 Apr	6	12	2					
27 Apr	5	11	3					
28 Apr	5	12	3	1				
29 Apr	6	15	2	1				
30 Apr	5	15			1			
02 May	5	10	2					
03 May	8	17	5	1				
04 May	2	5	4	1				
05 May	7	15	3		1			
06 May			3					
07 May			3	3		2		
08 May	2	4	2	3		2		
09 May				1		1		
10 May			4					
11 May			1				1	
12 May			1	2	1	1		
13 May	2	5				1		
14 May	2	4				2	1	
15 May	4	8	1			1		
16 May	2	4	1		1	1		
17 May	1	2		1				
18 May	1	2	3	1		2		1
19 May	13	28	2			2		
20 May	4	9		1				
21 May	7	22	2	1		1		1
22 May			2					1
23 May			2	2				
24 May			1					1
25 May	1	3	12	1				
26 May			6	1				
27 May	1	2	9	2	1			1
28 May			1	1				
29 May				2	1			
30 May			1			1		

Appendix Table 9. Continued.

	Valley Creek							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
02 Jun	2	5						
03 Jun			2	1				
04 Jun	2	4						
05 Jun	1	2						
06 Jun	1	3	2					
07 Jun	2	5	1					
08 Jun	4	9	1					1
09 Jun	1	2						
10 Jun				1				
12 Jun	1	2						
16 Jun			1					
18 Jun	1	3						
21 Jun			1					
26 Jun								1
Totals	119	272	90	29	7	18	2	7

Appendix Table 10. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 499 wild Chinook salmon from Camas Creek released 15-16 August 2008. Release sites were 524-527 km above Lower Granite Dam.

	Camas Creek							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
25 Apr	3	6						
26 Apr	2	4						
27 Apr								
28 Apr	2	5	1					
29 Apr								
30 Apr	3	9						
01 May	1	2						
02 May	1	2						
04 May			1					
05 May	2	4						
06 May	1	2	3					
07 May	1	2	4	1				
08 May	1	2						
09 May				1		1		
10 May			2					
11 May								
12 May	1	3						
13 May								
14 May	3	7				1		
15 May	2	4				1		
16 May								
17 May	1	2	1					
18 May	1	2						
19 May	4	9	1			1		
20 May			1			1		
21 May	1	3						
22 May	1	2	1					
23 May			2					
24 May			4		1		1	
25 May			3					
26 May	1	4	2					
27 May	1	2	2	1				
28 May			1					
29 May			1	2				
30 May								
01 Jun						1		
04 Jun							1	
05 Jun	1	2				1		
Totals	34	78	30	5	1	7	2	0

Appendix Table 11. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 500 wild Chinook salmon from Loon Creek released 12-13 August 2008. Release sites were 550-554 km above Lower Granite Dam.

	Loon Creek							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
16 Apr	1	2						
22 Apr	1	2						
23 Apr	1	2	1					
24 Apr	4	8		1				
26 Apr	6	12						
27 Apr	5	11	1					
28 Apr	11	26						
29 Apr	2	5	1					
30 Apr	1	3	2					
02 May			2	1				
03 May	6	13						
04 May	2	5	2		1			
05 May			1					
06 May	3	6	3	1	2			
07 May	4	8	2	4				
08 May			1	1				
09 May	2	5				2		
10 May	1	2		1				
11 May				1				
12 May			1			1		
13 May								
14 May	2	4				1		
15 May	2	4						
16 May	1	2						
17 May			2				1	
18 May	1	2	1				1	
19 May	5	11						
20 May	2	5				1		1
21 May	2	6	3	2				
22 May								
23 May				2				
24 May								
25 May			2					
26 May			2					
27 May			1					
28 May								
29 May								
30 May								
31 May								
04 Jun								
05 Jun								
10 Jun								
Totals	65	145	28	14	3	5	2	1

Appendix Table 12. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 942 wild Chinook salmon from Big Creek (upper) released 12-14 August 2008. Release sites were 535-537 km above Lower Granite Dam.

	Big Creek (upper)							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
22 Apr	1	2						
25 Apr	3	6						
26 Apr	1	2						
28 Apr	2	5						
29 Apr	2	5	1					
30 Apr			1					
01 May	1	2		1				
03 May	1	2						
04 May	2	5						
05 May	1	2	1					
06 May	1	2	1		1			
07 May	1	2						
08 May			1					
12 May	1	3			1			
13 May	1	2						
14 May	2	4	2			1		
15 May	1	2	1					
18 May			1			1		
19 May	2	4						
20 May	4	9				1		
21 May	5	16						
22 May	3	7	1	1				
23 May			1					
24 May				1	1			
25 May	2	5	12	1			1	
26 May			11	2				
27 May	1	2	8	3				
28 May	3	6	1	3				
29 May	2	4	3	1				
30 May	1	3				2		
31 May			1					
01 Jun			1	1		1		
02 Jun				1	1			
03 Jun			1				1	
04 Jun	1	2	1				2	
05 Jun							1	
07 Jun	1	2	2	1				
08 Jun							2	
09 Jun			1					
10 Jun			1					
11 Jun			1					
18 Jun			1					
26 Jun						1		
29 Jun						1		
02 Jul						1		
Totals	46	107	56	16	4	9	7	0

Appendix Table 13. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 879 wild Chinook salmon from Big Creek (lower) released 17-20 August 2008. Release sites were 489-499 km above Lower Granite Dam.

	Big Creek (lower)							
	Lower Granite		First Detections					
Detection late	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
03 Apr	1	3						
14 Apr	1	3						
18 Apr	2	4						
19 Apr	1	2						
20 Apr	1	2	1	1				
21 Apr	1	2						
22 Apr	1	2						
23 Apr								
24 Apr	11	22		1				
25 Apr	11	21						
26 Apr	14	28	2					
27 Apr	9	20	2					
28 Apr	8	19	1					
29 Apr	8	21	3					
30 Apr	7	21	6		2			
01 May	5	12	1	1	1			
02 May	6	12	3		1			
03 May	7	15	6	1		1		
04 May	5	11	2	3				
05 May	1	2	8	2				
06 May	3	6	4	5	1			
07 May	6	12	4	4		2		
08 May	2	4	5	2		1		
09 May						1		
10 May						1		
11 May						4		
12 May			3			2		
13 May						1		
14 May						4		
15 May								
16 May	1	2		1				
17 May	1	2						
18 May	1	2		1				
19 May	2	4	2			1		
20 May			1					
21 May	2	6					1	
22 May			2					
23 May								
24 May			1					
25 May			1					
28 May								
Totals	118	261	58	22	5	18	1	0

Appendix Table 14. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 790 wild Chinook salmon from West Fork Chamberlain/Chamberlain Creeks released 20-21 August 2008. Release sites were 437-438 km above Lower Granite Dam.

	West Fork Chamberlain/Chamberlain Creeks							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
13 Apr	2	5						
20 Apr	1	2						
21 Apr	1	2						
22 Apr								
24 Apr	5	10	1					
25 Apr	3	6						
26 Apr	4	8						
27 Apr	5	11	2					
28 Apr	7	16	1					
29 Apr	6	15		1				
30 Apr	6	18						
01 May	1	2	2					
02 May	2	4	2					
03 May	4	9	6					
04 May	4	9	2					
05 May			3					
06 May	4	9	4	1				
07 May	1	2	5	5		2		
08 May			3	2	1			
09 May	1	3	1			2		
10 May	1	2						
11 May			1					
12 May	3	8						
13 May	1	2						
14 May			1		1			
15 May	2	4	1					
16 May			2					
18 May	1	2				2		
19 May								
20 May	1	2				1		
21 May								
22 May			1					
24 May			3					
25 May	2	5	5				1	
26 May	1	4	6					
27 May				1				
29 May								
30 May				1				
02 Jun							1	
10 Jun	1	2	1					
25 Jun	1	2						
Totals	71	165	53	11	2	7	2	0

Appendix Table 15. Detections during 2009 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 526 wild Chinook salmon from South Fork Salmon River released 25 August 2008. Release sites were 467-468 km above Lower Granite Dam.

	South Fork Salmon River								
	Lower Granite		First Detections						
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville	
02 Apr	1	3							
14 Apr			1						
19 Apr			1						
24 Apr	2	4	1						
25 Apr	4	8							
26 Apr	1	2							
27 Apr	2	4							
28 Apr	1	2	1						
29 Apr	2	5							
30 Apr	1	3							
01 May			2		1				
02 May									
03 May	2	4		1					
04 May	2	5	4			1			
05 May	2	4	2	1					
06 May	1	2	1	2					
07 May			2	3		1			
08 May						2			
09 May	1	3	1						
10 May			2						
11 May									
12 May			1	1		1			
13 May						2			
14 May	3	7					1		
15 May						1			
16 May			2						
18 May									
19 May	3	7				1			
20 May	1	2			1				
21 May			2						
22 May			1	1					
23 May			2						
24 May									
25 May			3			1			
26 May	1	4	3						
27 May			1	1	1		1		
28 May								1	
29 May	2	4							
30 May	1	3							
01 Jun				1		1			
02 Jun									
04 Jun			1						
Totals	33	76	34	11	3	11	2	1	

Appendix Table 16. Detections during 2009 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 564 wild Chinook salmon from Secesh River released 27 August 2008. Release sites were 429-431 km above Lower Granite Dam.

	Secesh River							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
09 Apr								
11 Apr	1	3						
15 Apr	1	2	1					
19 Apr	2	4	1					
20 Apr	2	4						
21 Apr	1	2						
22 Apr	2	4	1					
23 Apr	1	2						
24 Apr	3	6						
25 Apr	4	8						
26 Apr	6	12	1					
27 Apr								
28 Apr	6	14	1					
29 Apr	1	3	1					
30 Apr	3	9			1			
01 May	1	2	2					
02 May	1	2						
03 May	2	4	2	1		1		
04 May	2	5	2					
05 May	1	2	1	1	1			
06 May	1	2	2	1		1		
08 May			1	1				
09 May			1			1		
11 May								
12 May	1	3						
13 May								
15 May	1	2	2					
16 May	1	2				1		
17 May	1	2						
19 May	2	4	1	1				
20 May	1	2						
21 May	1	3	1					
22 May			1					
23 May								
24 May								
25 May			2					
26 May			2					
27 May								
30 May				1		1		
02 Jun	1	2						
04 Jun			1					
22 Jun						1		
Totals	50	112	27	6	2	6	0	0

Appendix Table 17. Detections during 2009 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 511 wild Chinook salmon from Lake Creek released 28 August 2008. Release sites were 451-452 km above Lower Granite Dam.

	Lake Creek							
	Lower Granite		First Detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
04 Apr	1	3						
23 Apr	1	2						
24 Apr	2	4						
26 Apr	2	4						
27 Apr			1					
30 Apr	1	3						
02 May	3	6						
03 May	2	4	1					
04 May	2	5	1		1			
05 May			3					
06 May	1	2		1				
07 May								
08 May	1	2						
09 May								
10 May						2		
11 May								
12 May			1					
13 May								
14 May								
16 May	1	2						
17 May	1	2						
18 May								
19 May	2	4				2		
20 May								
21 May			1					
23 May								
24 May			1					
25 May			2					
26 May	1	4	2					
27 May			3					
28 May			1		1			
30 May	1	3						
31 May						1		
01 Jun			1					
03 Jun			2					
04 Jun								1
05 Jun	1	2						
13 Jun					1			
14 Jun			1					
17 Jun								1
20 Jun	1	2						
Totals	24	55	21	1	3	5	0	2

Appendix Table 18. Daily and expanded detections (with estimated detection efficiencies) of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho and Oregon at Lower Granite Dam during 2009, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

				Detections			
				Idaho only		Idaho and Oregon	
Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	N	Expanded	N	Expanded (detection efficiency)
01 Apr	53.5	0.0	6.3	0	0	0	0
02 Apr	58.7	0.0	6.1	2	6	3	8 (0.357)
03 Apr	63.9	20.1	6.0	1	3	1	3 (0.385)
04 Apr	59.4	20.2	5.8	1	3	2	6 (0.357)
05 Apr	64.0	20.2	6.1	0	0	0	0
06 Apr	64.1	20.3	6.3	0	0	2	5 (0.377)
07 Apr	64.9	20.5	6.7	0	0	0	0
08 Apr	66.2	20.6	7.3	0	0	0	0
09 Apr	79.8	20.6	7.7	0	0	0	0
10 Apr	83.0	20.6	8.1	1	3	1	3 (0.348)
11 Apr	80.4	20.3	8.3	1	3	5	14 (0.365)
12 Apr	83.4	20.4	8.1	0	0	2	6 (0.362)
13 Apr	88.0	20.3	8.2	2	5	10	26 (0.383)
14 Apr	94.5	20.4	7.9	1	3	5	13 (0.388)
15 Apr	89.9	20.5	8.1	1	2	3	7 (0.406)
16 Apr	82.1	20.4	7.9	2	5	4	10 (0.403)
17 Apr	82.5	20.5	7.6	3	7	8	18 (0.444)
18 Apr	81.1	20.4	7.7	4	9	7	15 (0.461)
19 Apr	83.6	20.5	8.2	6	13	9	19 (0.462)
20 Apr	90.5	20.4	8.6	6	13	8	17 (0.473)
21 Apr	103.8	20.5	9.0	7	15	8	17 (0.476)
22 Apr	122.7	22.3	9.3	10	21	14	30 (0.474)
23 Apr	140.7	33.0	9.3	8	16	15	30 (0.500)
24 Apr	139.8	36.3	9.1	42	83	54	106 (0.508)
25 Apr	120.8	21.1	8.6	42	82	54	105 (0.515)
26 Apr	108.8	20.4	8.4	53	106	58	116 (0.499)
27 Apr	98.2	19.7	8.5	38	83	46	101 (0.457)
28 Apr	91.1	20.5	8.7	60	141	66	155 (0.425)
29 Apr	87.6	20.5	8.7	39	100	46	118 (0.390)
30 Apr	81.5	20.5	8.6	41	123	45	135 (0.333)
01 May	78.9	20.5	8.6	17	39	21	49 (0.431)
02 May	74.9	20.5	9.0	22	45	24	49 (0.487)
03 May	77.1	20.5	9.4	47	102	58	126 (0.459)
04 May	86.0	22.8	9.7	30	68	40	91 (0.439)
05 May	89.0	20.4	9.8	17	36	26	56 (0.465)
06 May	109.2	20.6	9.9	19	41	28	60 (0.463)
07 May	107.1	20.7	10.1	15	30	21	43 (0.493)
08 May	107.3	20.5	9.9	8	16	17	35 (0.487)
09 May	98.4	20.6	9.9	6	16	10	26 (0.378)
10 May	87.2	20.5	10.0	2	4	2	4 (0.450)

Appendix Table 18. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Detections			
				Idaho only		Idaho and Oregon	
				N	Expanded	N	Expanded (detection efficiency)
11 May	78.5	20.4	10.2	2	6	5	14 (0.352)
12 May	82.5	20.6	10.5	11	29	16	42 (0.383)
13 May	84.5	20.3	10.9	5	11	10	23 (0.440)
14 May	90.1	20.5	10.9	15	33	25	54 (0.460)
15 May	95.1	20.5	10.3	16	31	30	59 (0.512)
16 May	96.2	20.6	10.5	8	16	15	30 (0.504)
17 May	99.3	20.6	10.9	7	13	14	26 (0.531)
18 May	108.6	20.6	11.5	10	20	20	39 (0.510)
19 May	139.8	31.4	12.3	39	85	63	137 (0.459)
20 May	162.2	59.1	12.0	18	41	32	73 (0.436)
21 May	161.1	51.7	10.5	24	76	31	98 (0.316)
22 May	143.0	37.0	10.5	5	12	7	16 (0.428)
23 May	137.7	43.2	10.7	0	0	0	0
24 May	145.2	56.9	11.3	0	0	0	0
25 May	164.6	57.1	11.9	5	13	6	15 (0.387)
26 May	163.9	56.5	11.7	4	16	5	20 (0.254)
27 May	156.9	52.9	11.4	4	9	7	16 (0.438)
28 May	157.3	54.3	11.6	3	6	4	8 (0.529)
29 May	160.9	57.2	11.8	4	8	5	10 (0.509)
30 May	160.9	64.8	12.2	3	10	3	10 (0.298)
31 May	169.3	76.7	12.4	0	0	2	11 (0.184)
01 Jun	167.6	75.3	12.5	0	0	0	0
02 Jun	160.1	63.8	12.4	3	7	3	7 (0.432)
03 Jun	148.7	43.3	12.3	0	0	0	0
04 Jun	142.5	40.5	12.6	3	5	4	7 (0.570)
05 Jun	147.6	40.1	12.9	4	8	4	8 (0.482)
06 Jun	158.2	49.7	13.3	1	3	3	8 (0.371)
07 Jun	171.2	61.4	13.3	4	10	4	10 (0.405)
08 Jun	158.0	48.2	12.8	4	9	4	9 (0.426)
09 Jun	138.5	29.5	12.7	2	5	4	10 (0.419)
10 Jun	125.6	20.6	13.1	1	2	1	2 (0.473)
11 Jun	109.5	20.5	13.5	0	0	0	0
12 Jun	106.6	20.8	13.9	1	2	1	2 (0.533)
13 Jun	96.7	20.7	14.3	0	0	1	1 (0.786)
14 Jun	99.7	20.8	14.7	0	0	0	0
15 Jun	101.0	20.6	14.8	0	0	0	0
16 Jun	108.4	20.5	14.7	1	3	1	3 (0.359)
17 Jun	104.2	20.5	14.9	0	0	0	0
18 Jun	101.5	20.7	15.1	1	3	1	3 (0.292)
19 Jun	102.8	20.7	15.6	0	0	0	0
20 Jun	92.8	20.7	15.5	1	2	1	2 (0.458)
21 Jun	88.5	18.8	15.4	0	0	0	0
22 Jun	89.0	18.7	15.1	0	0	0	0

Appendix Table 18. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Detections			
				Idaho only		Idaho and Oregon	
				N	Expanded	N	Expanded (detection efficiency)
23 Jun	108.2	18.8	14.6	0	0	0	0
24 Jun	97.8	18.8	14.4	0	0	0	0
25 Jun	85.2	18.7	15.0	1	2	1	2 (0.447)
26 Jun	85.2	18.8	15.7	0	0	0	0
27 Jun	80.7	18.8	16.2	0	0	0	0
28 Jun	84.1	18.7	16.7	0	0	0	0
29 Jun	77.8	18.8	17.4	0	0	0	0
30 Jun	75.1	18.7	17.7	0	0	0	0
01 Jul	71.9	18.6	18.0	0	0	0	0
02 Jul	69.5	18.7	18.5	0	0	0	0
03 Jul	68.7	18.8	18.8	0	0	0	0
04 Jul	68.8	18.8	19.0	0	0	0	0
05 Jul	68.2	18.8	19.2	0	0	0	0
06 Jul	62.3	18.6	19.1	0	0	0	0
07 Jul	62.4	18.7	19.1	0	0	0	0
08 Jul	63.2	18.6	19.1	0	0	0	0

Appendix Table 19. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Little Goose Dam during 2009, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Numbers detected
14 Apr	90.5	27.0	8.3	1
15 Apr	88.3	26.5	8.2	1
19 Apr	79.9	23.8	8.2	2
20 Apr	86.2	25.8	8.1	2
21 Apr	100.8	30.1	8.2	1
22 Apr	114.4	31.5	8.9	1
23 Apr	134.4	45.8	9.3	1
24 Apr	134.8	44.9	9.5	4
26 Apr	103.2	30.5	9.4	10
27 Apr	96.1	28.9	9.2	17
28 Apr	86.3	25.9	8.9	10
29 Apr	84.5	27.4	8.8	14
30 Apr	78.6	24.0	8.9	12
01 May	74.9	22.3	8.9	14
02 May	73.5	22.0	9.1	11
03 May	73.6	22.0	9.3	27
04 May	83.9	25.2	9.2	20
05 May	84.8	25.4	9.5	28
06 May	104.5	30.8	9.9	30
07 May	104.4	30.9	10.2	23
08 May	103.4	31.2	10.3	16
09 May	91.9	27.4	10.4	4
10 May	85.8	25.7	10.5	9
11 May	76.0	22.8	11.0	4
12 May	77.7	23.1	10.8	7
13 May	83.5	25.0	10.8	2
14 May	85.5	25.5	10.8	5
15 May	91.7	27.4	11.0	6
16 May	93.8	28.1	11.5	5
17 May	95.4	28.7	11.3	5
18 May	104.2	31.1	11.4	6
19 May	132.6	35.8	11.7	6
20 May	150.0	40.5	12.1	7
21 May	152.1	42.1	12.6	12
22 May	133.2	29.4	12.2	11
23 May	127.6	29.4	11.2	12
24 May	137.0	30.9	11.3	13
25 May	153.8	45.2	11.6	50

Appendix Table 19. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Numbers detected
26 May	152.5	43.0	12.2	43
27 May	147.1	37.3	12.6	27
28 May	145.9	36.1	12.2	5
29 May	149.9	40.6	12.1	4
30 May	153.2	44.0	12.3	1
31 May	159.7	50.7	12.7	2
01 Jun	156.4	47.7	12.9	3
03 Jun	138.3	28.9	13.0	6
04 Jun	132.4	25.8	13.0	3
06 Jun	148.0	40.2	13.2	3
07 Jun	158.7	49.7	13.4	3
08 Jun	147.7	41.6	13.7	1
09 Jun	130.9	30.1	13.4	1
10 Jun	117.4	30.0	13.2	2
11 Jun	102.7	29.0	13.4	1
13 Jun	94.0	28.2	14.1	0
14 Jun	93.9	28.1	14.6	1
16 Jun	102.9	31.1	15.3	1
18 Jun	96.8	29.0	15.7	1
21 Jun	83.9	25.2	15.4	1
23 Jun	103.7	31.0	15.5	0
29 Jun	75.3	22.4	16.5	0

Appendix Table 20. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Lower Monumental Dam during 2009, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Numbers detected
20 Apr	88.6	25.9	8.8	2
24 Apr	142.0	28.2	9.6	2
25 Apr	119.4	29.0	9.7	1
28 Apr	88.3	26.3	9.5	1
29 Apr	85.7	26.1	9.4	6
30 Apr	80.7	32.6	9.2	1
01 May	77.2	36.2	9.2	4
02 May	74.3	30.9	9.3	1
03 May	74.3	28.9	9.4	5
04 May	85.9	33.7	9.6	4
05 May	84.8	37.0	9.7	4
06 May	109.7	27.2	9.7	12
07 May	108.1	25.5	10.0	24
08 May	108.8	33.9	10.3	11
09 May	93.9	33.5	10.5	2
10 May	88.9	35.1	10.6	2
11 May	77.2	34.4	11.1	1
12 May	81.0	26.9	11.2	3
14 May	87.1	31.8	11.0	1
16 May	97.1	27.5	11.2	1
17 May	98.0	26.3	11.7	1
18 May	106.7	25.6	12.2	2
19 May	139.2	28.9	12.0	2
20 May	156.0	39.8	11.9	1
21 May	162.4	46.0	12.4	5
22 May	139.3	27.5	12.8	4
23 May	132.5	24.6	12.7	4
24 May	144.0	35.1	11.8	3
25 May	161.5	46.0	11.7	2
26 May	160.1	43.4	11.9	4
27 May	156.4	40.4	12.4	10
28 May	150.8	36.7	12.8	5
29 May	158.8	42.5	12.6	6
30 May	159.8	43.1	12.6	2
01 Jun	162.7	54.3	13.0	2
02 Jun	158.5	49.1	13.2	1
03 Jun	145.5	29.6	13.2	1
07 Jun	166.4	49.3	13.4	1
10 Jun	119.6	20.0	14.0	1

Appendix Table 21. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Ice Harbor Dam during 2009, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average Spill(kcfs)	Water temperature (°C)	Numbers detected
24 Apr	145.9	75.4	9.3	1
30 Apr	81.5	34.8	9.7	4
01 May	78.7	23.7	9.7	3
02 May	75.6	46.9	9.7	1
04 May	88.1	36.0	9.7	3
05 May	85.7	25.7	9.9	3
06 May	112.0	54.3	10.1	4
07 May	109.4	69.9	10.1	1
08 May	109.5	46.8	10.2	2
12 May	81.8	47.7	11.3	2
14 May	89.1	37.8	11.4	1
16 May	99.2	51.8	11.5	1
20 May	160.5	81.4	12.3	1
23 May	134.9	71.9	13.2	1
24 May	147.2	66.6	13.3	2
25 May	165.0	81.5	12.4	1
27 May	159.9	77.3	12.3	2
28 May	154.6	74.5	12.7	1
29 May	162.5	78.8	13.1	1
01 Jun	167.2	84.1	13.1	1
02 Jun	163.5	80.8	13.3	1
13 Jun	96.2	41.8	14.3	1

Appendix Table 22. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at McNary Dam during 2009, with associated river flows (kcfs), spill (kcfs), and water temperatures at the dam.

Date	Average flow (kcfs)	Average Spill (kcfs)	Water temperature (°C)	Numbers detected
25 Apr	292.0	120.9	8.7	1
03 May	188.5	75.5	9.1	2
04 May	190.5	76.3	9.2	1
05 May	195.9	78.4	9.3	2
06 May	237.9	95.6	9.6	4
07 May	223.5	89.4	10.0	8
08 May	214.4	85.9	10.1	6
09 May	240.1	96.2	10.6	10
10 May	215.1	86.0	10.9	4
11 May	226.8	91.0	11.0	5
12 May	252.0	100.8	11.0	7
13 May	248.4	99.5	11.0	4
14 May	223.9	89.7	11.0	9
15 May	239.7	96.0	11.0	3
16 May	250.8	100.4	11.6	3
17 May	232.3	92.9	11.9	1
18 May	258.9	103.7	12.1	7
19 May	279.4	112.0	12.5	7
20 May	297.3	128.0	12.6	6
21 May	313.3	139.8	12.9	1
25 May	330.3	161.1	13.6	1
30 May	343.4	169.1	13.9	4
31 May	340.7	165.3	14.0	1
01 Jun	345.5	170.5	14.2	3
05 Jun	353.3	176.8	14.5	1
22 Jun	239.0	119.5	16.4	1
26 Jun	229.6	114.8	16.6	1
29 Jun	224.2	112.5	17.1	1
02 Jul	147.0	73.5	17.5	1

Appendix Table 23. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at John Day Dam during 2009, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average Spill (kcfs)	Water temperature (°C)	Numbers detected
11 May	232.0	87.6	10.7	1
14 May	222.7	66.6	11.3	2
17 May	238.3	76.1	11.9	1
18 May	259.8	78.0	12.1	1
19 May	268.2	80.4	12.4	1
20 May	304.6	91.6	12.6	1
21 May	307.5	102.4	13.1	2
24 May	301.4	108.5	13.6	1
25 May	322.3	103.1	13.8	2
27 May	338.5	114.7	14.1	1
02 Jun	340.9	90.0	15.2	1
03 Jun	338.6	90.0	15.2	1
04 Jun	335.3	90.0	15.2	3
05 Jun	344.0	89.9	15.3	1
08 Jun	353.0	84.9	15.6	2

Appendix Table 24. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Bonneville Dam during 2009, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average Spill(kcfs)	Water temperature (°C)	Numbers Detected
15 May	252.5	99.7	11.5	1
18 May	255.9	84.9	12.7	1
20 May	307.9	119.4	12.7	1
21 May	320.2	131.3	12.9	1
22 May	329.3	139.0	13.3	1
24 May	291.4	104.3	13.8	1
27 May	341.4	149.6	14.3	1
28 May	340.4	149.5	14.5	1
04 Jun	344.3	149.5	15.6	1
08 Jun	354.4	158.7	15.6	1
17 Jun	231.3	99.5	16.6	1
26 Jul	134.9	83.3	21.2	1

Appendix Table 25. Monthly environmental data collected from Marsh Creek (rkm 179.8 from the mouth of the Middle Fork Salmon River) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	5.3	2.6	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	0.0	3.0	5.8
Max.	18.3	14.6	11.8	5.1	3.8	1.9	4.3	6.9	10.3	12.8	16.2	19.1
Ave.	11.8	8.2	4.2	1.9	0.2	-0.1	0.7	1.5	3.3	4.6	8.1	12.2
						Dissolved oxygen (ppm)						
Min.	6.6	8.6	8.8	---	---	---	---	---	10.8	---	---	---
Max.	12.4	12.3	15.2	---	---	---	---	---	15.2	---	---	---
Ave.	9.2	10.4	11.2	---	---	---	---	---	12.8	---	---	---
						Specific conductance (µS/cm)						
Min.	51.0	67.0	59.0	53.0	55.0	50.0	53.0	57.0	45.0	28.0	29.0	42.0
Max.	70.0	70.0	71.0	67.0	71.0	71.0	71.0	71.0	69.0	56.0	42.0	51.0
Ave.	64.2	69.0	67.4	63.3	66.0	65.8	65.4	66.3	61.2	39.7	35.8	47.0
						Turbidity (ntu)						
Min.	---	---	---	---	---	---	---	---	---	---	---	---
Max.	---	---	---	---	---	---	---	---	---	---	---	---
Ave.	---	---	---	---	---	---	---	---	---	---	---	---
						Depth (ft)						
Min.	0.6	0.7	0.6	0.4	0.0	0.3	0.1	0.2	0.4	1.2	1.8	1.2
Max.	1.7	1.3	1.3	1.3	2.9	3.5	1.9	1.1	1.6	3.5	3.4	1.9
Ave.	1.2	1.0	1.0	0.9	1.4	1.9	0.7	0.5	1.0	2.4	2.5	1.6
						pH						
Min.	7.2	7.7	7.6	7.5	7.6	7.6	7.7	7.3	6.8	6.6	6.9	7.3
Max.	9.0	9.3	9.2	9.0	9.2	8.1	9.1	8.8	8.2	7.3	7.7	8.5
Ave.	7.9	8.1	7.9	7.9	7.9	7.8	8.0	7.9	7.3	6.9	7.3	7.7

Appendix Table 26. Monthly environmental data collected from the Salmon River near Sawtooth Hatchery (rkm618) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	8.1	5.3	1.2	0.0	0.0	0.0	0.0	-0.2	-0.2	1.9	5.8	8.8
Max.	19.5	16.2	13.8	7.7	4.5	4.1	6.4	8.3	11.9	13.9	17.8	20.4
Ave.	13.7	10.2	6.2	3.8	1.0	0.8	1.6	2.9	5.3	7.7	10.1	14.3
						Dissolved oxygen (ppm)						
Min.	---	---	---	9.8	9.4	12.2	6.1	9.3	8.4	7.7	7.6	7.4
Max.	---	---	---	13.7	14.8	15.2	15.2	15.2	12.1	11.8	11.2	11.3
Ave.	---	---	---	11.5	12.9	13.6	13.6	12.7	10.0	9.6	9.2	8.9
						Specific conductance (µS/cm)						
Min.	112.0	---	---	140.0	137.0	132.0	144.0	142.0	113.0	79.0	70.0	78.0
Max.	159.0	---	---	159.0	159.0	158.0	159.0	159.0	158.0	129.0	85.0	127.0
Ave.	128.7	---	---	150.5	149.6	144.8	151.3	148.5	143.0	106.1	77.4	101.3
						Turbidity (ntu)						
Min.	---	---	---	---	---	---	---	---	---	---	---	---
Max.	---	---	---	---	---	---	---	---	---	---	---	---
Ave.	---	---	---	---	---	---	---	---	---	---	---	---
						Depth (ft)						
Min.	1.0	1.1	1.0	0.9	0.3	0.5	0.5	0.6	1.0	1.6	2.4	1.7
Max.	2.3	1.8	1.9	1.8	1.5	2.3	1.4	1.5	2.1	3.1	3.2	2.6
Ave.	1.6	1.5	1.5	1.4	1.0	1.3	1.0	1.0	1.5	2.3	2.7	2.1
						pH						
Min.	7.4	8.0	7.9	7.8	7.5	7.2	7.1	7.1	7.6	7.4	7.3	7.4
Max.	9.2	9.3	9.4	8.4	8.3	7.8	7.4	8.4	8.7	8.7	8.7	8.8
Ave.	8.3	8.5	8.4	8.0	7.9	7.4	7.2	7.8	8.1	7.8	7.7	8.0

Appendix Table 27. Monthly environmental data collected from Valley Creek (rkm 609.4 from the mouth of the Salmon River; 0.4 km from the mouth of Valley Creek) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	7.6	3.9	0.2	0.2	0.0	0.0	0.1	0.1	0.1	0.5	5.4	7.9
Max.	22.2	17.3	15.0	6.5	3.5	0.8	0.9	6.2	10.3	14.2	18.2	22.6
Ave.	14.7	10.3	5.1	2.2	0.5	0.3	0.3	2.0	3.9	7.2	9.9	14.8
						Dissolved oxygen (ppm)						
Min.	4.7	5.6	6.0	11.9	13.9	13.8	13.7	12.5	11.6	8.8	---	---
Max.	10.5	8.2	15.1	15.2	15.2	15.2	15.2	14.6	14.9	15.2	---	---
Ave.	6.5	6.8	9.2	13.9	14.6	14.4	14.3	13.6	13.2	13.0	---	---
						Specific conductance (µS/cm)						
Min.	48.0	69.0	67.0	54.0	66.0	70.0	72.0	72.0	47.0	37.0	35.0	42.0
Max.	72.0	77.0	75.0	73.0	87.0	77.0	78.0	85.0	83.0	59.0	44.0	62.0
Ave.	63.4	72.7	71.1	66.0	71.9	73.8	74.1	77.3	69.3	45.3	39.3	52.8
						Turbidity (ntu)						
Min.	0.0	-0.1	-0.2	1.7	34.2	169	110	---	0.0	2.0	1.4	1.2
Max.	60.1	177.1	6.2	226.1	504	513	468	---	485	483	39.4	95.2
Ave.	3.9	2.2	0.9	20.2	176	357	190	---	7.1	5.6	3.8	8.6
						Depth (ft)						
Min.	0.9	1.0	0.9	0.6	0.1	0.4	0.5	0.6	0.7	1.7	2.2	1.5
Max.	2.1	1.6	1.7	1.7	1.3	1.7	1.4	1.3	2.6	3.3	3.3	2.4
Ave.	1.5	1.4	1.3	1.2	0.9	1.2	0.9	1.0	1.5	2.5	2.7	1.9
						pH						
Min.	7.4	7.6	7.6	7.5	7.3	7.3	7.4	7.4	7.0	6.8	6.9	7.1
Max.	8.4	8.3	8.3	8.2	8.4	7.9	7.8	7.7	7.9	7.7	7.9	8.2
Ave.	7.8	7.9	7.9	7.8	7.7	7.5	7.6	7.5	7.4	7.2	7.3	7.5

Appendix Table 28. Monthly environmental data collected from the South Fork Salmon River (rkm 112 from its confluence with the main Salmon River) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	8.8	5.4	0.4	-0.2	-0.2	-0.2	-0.2	-0.2	0.0	---	---	---
Max.	19.9	14.8	13.2	5.8	2.8	1.1	2.7	4.9	6.8	---	---	---
Ave.	14.4	9.8	4.9	2.0	0.1	-0.1	0.3	1.0	2.5	---	---	---
						Dissolved oxygen (ppm)						
Min.	8.3	10.1	10.8	11.8	---	---	---	---	---	---	---	---
Max.	11.8	13.6	15.2	15.2	---	---	---	---	---	---	---	---
Ave.	9.9	11.7	12.6	13.8	---	---	---	---	---	---	---	---
						Specific conductance (µS/cm)						
Min.	47.0	46.0	48.0	44.0	53.0	55.0	55.0	40.0	43.0	---	---	---
Max.	61.0	52.0	66.0	66.0	74.0	68.0	69.0	68.0	52.0	---	---	---
Ave.	53.7	50.2	55.0	58.4	61.7	63.1	61.8	57.0	47.4	---	---	---
						Turbidity (ntu)						
Min.	---	---	---	---	---	---	---	---	---	---	---	---
Max.	---	---	---	---	---	---	---	---	---	---	---	---
Ave.	---	---	---	---	---	---	---	---	---	---	---	---
						Depth (ft)						
Min.	1.0	2.7	1.0	0.6	0.4	0.8	0.4	0.6	0.7	---	---	---
Max.	3.2	3.2	3.5	2.1	2.5	3.4	2.6	2.0	3.2	---	---	---
Ave.	1.9	3.0	2.5	1.3	1.5	2.1	1.1	1.1	1.2	---	---	---
						pH						
Min.	7.1	7.4	7.5	7.2	7.4	7.4	7.4	7.1	---	---	---	---
Max.	8.4	8.6	8.7	8.0	7.9	7.7	8.8	9.7	----	---	---	---
Ave.	7.6	7.7	7.7	7.5	7.5	7.5	7.7	7.8	---	---	---	---

Appendix Table 29. Monthly environmental data collected from the Secesh River (rkm 27 from its confluence with the South Fork Salmon River) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	7.1	---	---	-0.1	0.0	0.0	0.0	0.0	0.0	0.2	3.2	6.9
Max.	18.5	---	---	4.7	0.1	0.0	0.0	0.0	5.7	10.2	14.7	18.3
Ave.	12.4	---	---	0.9	0.0	0.0	0.0	0.0	0.8	4.1	7.3	12.7
						Dissolved oxygen (ppm)						
Min.	9.0	---	---	12.0	13.4	13.7	14.2	13.7	11.7	8.6	6.1	---
Max.	11.9	---	---	15.2	15.2	14.8	15.2	15.0	14.6	14.7	10.0	---
Ave.	10.2	---	---	13.8	14.0	14.3	14.6	14.2	13.6	11.3	7.9	---
						Specific conductance (µS/cm)						
Min.	35.0	---	---	28.0	33.0	38.0	38.0	38.0	28.0	28.0	---	28.0
Max.	40.0	---	---	41.0	41.0	40.0	41.0	41.0	40.0	31.0	---	38.0
Ave.	37.0	---	---	36.9	37.7	38.8	39.8	39.3	33.7	29.0	---	33.2
						Turbidity (ntu)						
Min.	---	---	---	---	---	---	---	---	---	---	---	---
Max.	---	---	---	---	---	---	---	---	---	---	---	---
Ave.	---	---	---	---	---	---	---	---	---	---	---	---
						Depth (ft)						
Min.	0.9	---	0.7	0.3	0.8	1.3	1.4	2.0	1.4	1.4	2.0	1.0
Max.	1.5	---	1.2	2.1	2.2	2.8	2.7	3.1	3.6	4.5	4.4	2.2
Ave.	1.3	---	0.9	1.0	1.4	2.2	2.0	2.6	2.5	3.0	3.1	1.5
						pH						
Min.	6.9	---	7.2	7.0	6.8	6.8	6.9	6.9	6.8	6.6	6.6	7.1
Max.	8.2	---	7.6	7.7	7.8	7.0	7.1	7.1	7.3	8.0	7.6	8.4
Ave.	7.3	---	7.4	7.3	7.0	6.9	7.0	7.0	7.0	7.1	7.0	7.4

Appendix Table 30. Monthly environmental data collected from Big Creek near Taylor Ranch (rkm 10 from its confluence with the Middle Fork Salmon River) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	10.4	6.8	1.0	0.0	0.0	0.0	0.0	0.0	1.4	3.1	5.6	8.5
Max.	19.6	15.7	12.7	6.8	3.0	0.4	0.9	6.1	10.2	11.4	15.1	20.2
Ave.	14.9	10.7	5.4	2.5	0.3	0.0	0.1	1.3	5.3	7.0	9.1	14.2
						Dissolved oxygen (ppm)						
Min.	---	10.4	11.3	10.9	13.4	---	---	---	11.3	11.7	11.4	10.2
Max.	---	15.2	15.2	15.2	15.2	---	---	---	15.2	15.1	15.0	15.1
Ave.	---	12.5	13.3	13.3	14.7	---	---	---	13.2	13.5	13.5	12.4
						Specific conductance (µS/cm)						
Min.	35.0	111.0	117.0	111.0	131.0	131.0	126.0	125.0	86.0	54.0	54.0	79.0
Max.	153.0	132.0	142.0	155.0	158.0	158.0	147.0	153.0	148.0	115.0	80.0	114.0
Ave.	116.9	119.3	129.8	135.6	142.0	142.2	135.5	139.7	119.4	84.7	66.8	97.9
						Turbidity (ntu)						
Min.	-1.2	---	-1.3	-0.2	-0.3	-0.3	-0.2	0.2	1.0	3.9	1.2	0.0
Max.	201.6	---	9.2	419.4	359.0	198.4	15.40	464.7	183.7	248.2	457.5	23.6
Ave.	7.2	---	0.5	3.0	1.4	0.7	0.4	22.9	21.2	36.9	15.3	1..3
						Depth (ft)						
Min.	1.5	2.6	2.4	2.1	1.7	1.9	2.2	1.9	2.1	2.9	3.6	2.8
Max.	3.3	3.4	3.6	3.4	3.3	5.0	3.6	3.3	4.1	6.7	6.3	3.9
Ave.	2.3	3.0	3.0	2.8	2.5	3.4	2.9	2.5	3.0	4.5	4.5	3.2
						pH						
Min.	7.4	7.6	7.6	7.6	7.7	7.7	7.6	7.6	7.6	7.4	7.4	7.7
Max.	8.9	9.0	8.9	8.5	8.7	8.0	8.3	8.8	9.1	8.7	8.6	8.9
Ave.	8.0	8.1	7.9	7.8	7.9	7.8	7.9	8.0	8.0	7.8	7.8	8.2

Appendix Table 31. Monthly environmental data collected from Bear Valley/Elk Creek (rkm 14 from the confluence of Bear Valley Creek with the Middle Fork Salmon River; 50 m below the mouth of Elk Creek) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	9.0	5.3	0.4	-0.1	-0.1	0.0	0.0	0.0	0.0	0.1	6.4	8.6
Max.	19.4	15.0	12.2	4.3	1.5	0.0	0.4	0.8	5.7	13.4	17.4	19.9
Ave.	14.4	9.8	4.6	1.4	0.0	0.0	0.0	0.1	1.3	5.1	10.0	14.2
						Depth (ft)						
Min.	2.8	2.9	2.7	2.7	2.4	3.5	2.8	2.4	2.6	3.5	3.7	3.4
Max.	3.4	3.4	3.6	4.0	4.2	4.8	4.1	3.6	3.9	6.6	5.8	3.9
Ave.	3.2	3.2	3.2	3.3	3.3	4.3	3.4	3.0	3.3	5.0	4.5	3.6

Appendix Table 32. Monthly environmental data collected from Sulphur Creek (rkm 10 from its confluence with the Middle Fork Salmon River) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	6.6	4.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	4.2	6.2
Max.	16.0	12.1	10.3	4.7	2.8	1.7	2.4	4.6	6.2	10.1	15.2	17.3
Ave.	11.2	7.8	4.4	2.1	0.4	0.2	0.5	1.1	2.2	3.9	8.0	11.5
						Depth (ft)						
Min.	1.0	1.1	0.9	1.0	0.5	0.7	0.7	0.7	0.8	2.1	1.9	1.5
Max.	1.6	1.6	1.9	2.1	1.7	2.0	1.7	1.7	3.2	4.5	3.9	3.0
Ave.	1.4	1.4	1.4	1.6	1.2	1.4	1.2	1.2	1.9	3.2	2.7	1.9

Appendix Table 33. Monthly environmental data collected from upper Big Creek (rkm 60 from its confluence with the Middle Fork Salmon River) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	6.5	4.8	2.0	0.4	0.0	0.0	0.0	0.0	0.2	1.5	3.0	5.4
Max.	15.0	12.5	9.8	5.7	3.9	2.8	3.5	5.5	7.3	8.6	11.5	15.3
Ave.	10.2	7.9	4.8	3.0	1.0	0.7	1.1	1.6	2.8	4.2	5.8	9.7
						Depth (ft)						
Min.	1.5	1.6	1.4	1.3	1.0	1.1	1.3	1.2	1.4	1.9	2.7	2.0
Max.	2.2	2.2	2.4	2.5	2.2	3.1	2.9	2.6	2.9	4.5	4.2	2.9
Ave.	1.9	2.0	2.0	2.0	1.8	2.1	1.8	1.8	2.1	3.0	3.2	2.3

Appendix Table 34. Monthly environmental data collected from Chamberlain Creek (rkm 25 from its confluence with the main Salmon River) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	6.8	3.3	-0.1	-0.1	0.0	0.0	0.0	0.0	-0.1	0.1	3.7	6.9
Max.	17.4	13.6	10.2	5.9	2.0	0.0	1.7	2.9	6.7	10.6	15.6	19.0
Ave.	11.6	8.1	3.8	1.6	0.1	0.0	0.0	0.5	2.1	4.2	8.1	12.8
						Depth (ft)						
Min.	0.7	0.8	0.6	0.6	0.7	0.7	0.7	0.5	0.7	1.4	1.5	1.1
Max.	1.3	1.3	1.6	2.1	3.1	2.7	2.0	1.6	2.2	4.1	3.8	1.7
Ave.	1.0	1.1	1.2	1.4	1.8	1.5	1.1	1.1	1.5	2.4	2.2	1.4

Appendix Table 35. Monthly environmental data collected from West Fork Chamberlain Creek (rkm 25 from the confluence of Chamberlain Creek with the main Salmon River; 1 rkm from the mouth of West Fork Chamberlain Creek) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	6.1	3.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.3	4.2	5.9
Max.	15.2	11.5	8.8	4.9	1.9	0.7	1.9	2.9	6.0	10.6	15.1	16.9
Ave.	10.2	7.1	3.3	1.4	0.2	0.1	0.2	0.6	1.9	4.1	8.0	11.2
						Depth (ft)						
Min.	1.3	1.4	1.2	1.1	0.8	0.8	1.1	0.9	1.1	2.0	2.2	1.7
Max.	1.9	1.9	2.2	2.9	2.0	2.3	2.1	1.9	3.4	4.4	4.3	2.3
Ave.	1.6	1.7	1.7	1.8	1.5	1.8	1.5	1.5	2.0	3.5	3.0	2.0

Appendix Table 36. Monthly environmental data collected from Lake Creek (rkm 46 from the confluence of the Secesh River with the South Fork Salmon River; 1 rkm above the mouth of Lake Creek) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	---	---	---	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	2.7	5.7
Max.	---	---	---	4.2	0.5	0.0	0.0	0.3	5.1	8.2	13.6	16.9
Ave.	---	---	---	0.9	0.0	0.0	0.0	0.0	0.8	2.7	6.6	11.3
						Depth (ft)						
Min.	---	---	---	0.6	0.9	2.0	0.7	0.6	0.7	1.3	2.1	1.4
Max.	---	---	---	2.1	2.7	3.7	2.6	2.6	2.6	4.4	4.4	2.2
Ave.	---	---	---	1.4	1.8	3.0	1.4	1.4	1.3	2.6	2.9	1.7

Appendix Table 37. Monthly environmental data collected from Cape Horn Creek (rkm 180 from the mouth of the Middle Fork Salmon River; 150 m above the Marsh Creek monitoring site) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	---	---	---	-0.1	-0.1	0.0	0.0	-0.1	-0.1	-0.1	2.7	4.6
Max.	---	---	---	4.7	2.6	0.0	0.6	3.0	9.5	9.3	14.1	17.0
Ave.	---	---	---	1.2	0.1	0.0	0.0	0.2	2.6	3.5	6.5	9.9
						Depth (ft)						
Min.	---	---	---	0.4	0.3	0.6	0.6	0.3	0.5	0.8	1.3	1.0
Max.	---	---	---	1.6	1.9	1.8	1.9	1.4	1.5	2.3	2.3	1.6
Ave.	---	---	---	1.0	1.0	1.2	1.0	0.9	0.9	1.6	1.7	1.3

Appendix Table 38. Monthly environmental data collected from Herd Creek (rkm 15 from the confluence of the Salmon River and East Fork Salmon River; 1 rkm above the mouth of Herd Creek) from August 2008 through July 2009.

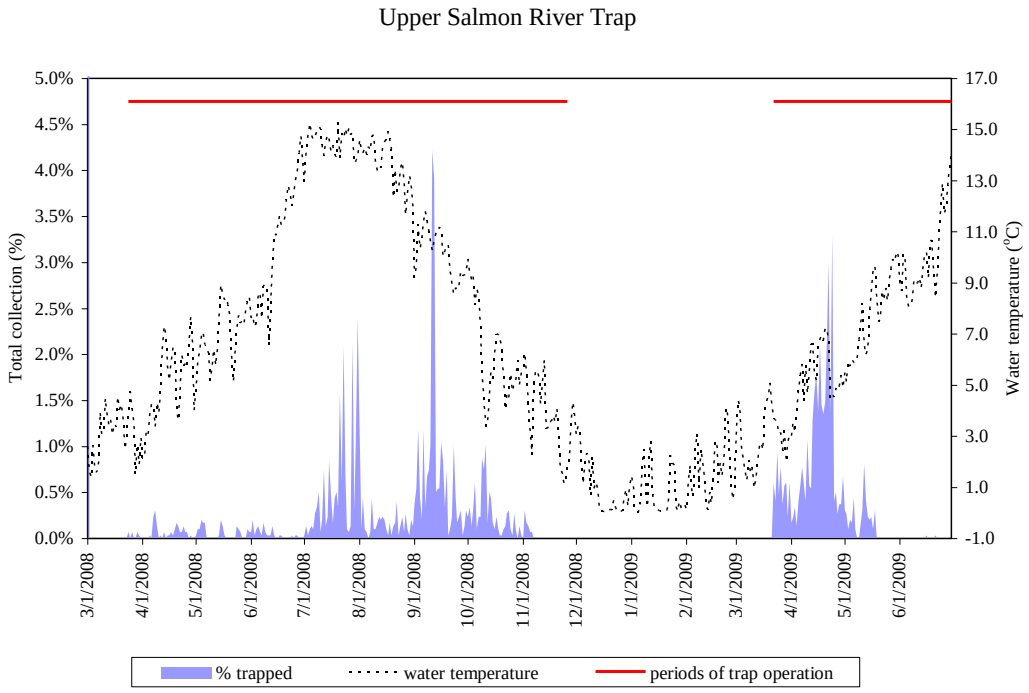
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	---	---	---	0.0	-2.0	-1.4	-0.5	-0.3	0.0	2.0	4.6	5.9
Max.	---	---	---	7.1	3.6	3.2	5.6	8.2	13.4	15.1	14.1	16.7
Ave.	---	---	---	2.9	0.4	0.3	0.8	2.3	5.4	8.0	8.1	11.1
						Depth (ft)						
Min.	---	---	---	0.1	0.0	0.0	0.0	0.0	0.0	0.4	1.3	1.9
Max.	---	---	---	1.1	2.3	2.3	1.0	0.9	1.1	1.7	3.2	2.6
Ave.	---	---	---	0.7	0.5	0.7	0.5	0.4	0.6	1.0	1.9	2.3

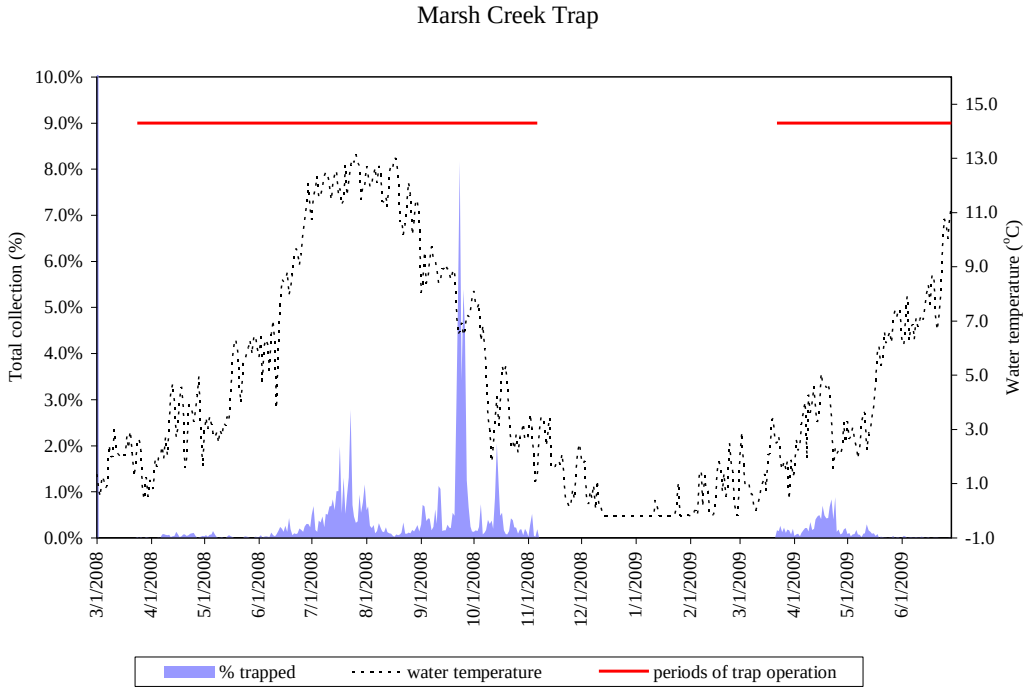
Appendix Table 39. Monthly environmental data collected from Camas Creek (rkm 23 from its confluence with the Middle Fork Salmon River) from August 2008 through July 2009.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	---	---	---	0.0	0.0	0.0	0.0	0.0	0.0	1.9	4.8	7.2
Max.	---	---	---	5.7	2.4	0.2	0.3	3.7	10.4	11.6	15.8	18.6
Ave.	---	---	---	1.8	0.1	0.0	0.1	0.6	3.6	6.4	8.5	12.8
						Depth (ft)						
Min.	---	---	---	0.5	0.1	0.4	0.4	0.3	0.4	1.6	2.0	1.3
Max.	---	---	---	1.7	1.6	1.8	1.5	1.2	3.1	6.1	5.6	2.3
Ave.	---	---	---	1.1	0.9	1.1	0.9	0.8	1.6	3.2	3.0	1.8

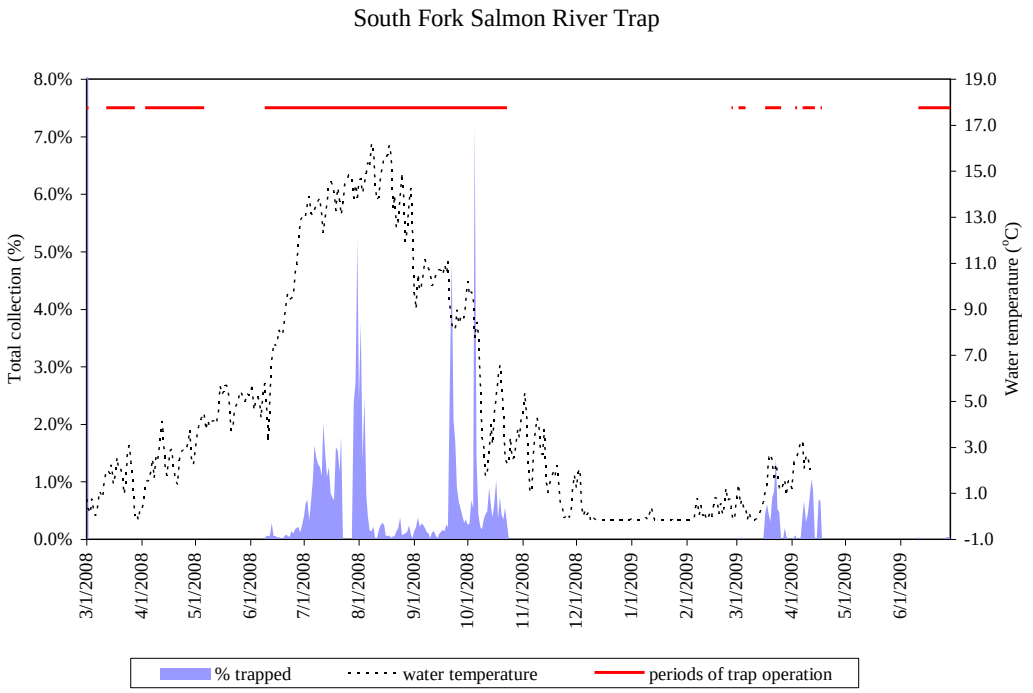
Appendix Table 40. Monthly environmental data collected from Loon Creek (rkm 31 from its confluence with the Middle Fork Salmon River) from August 2008 through July 2009.

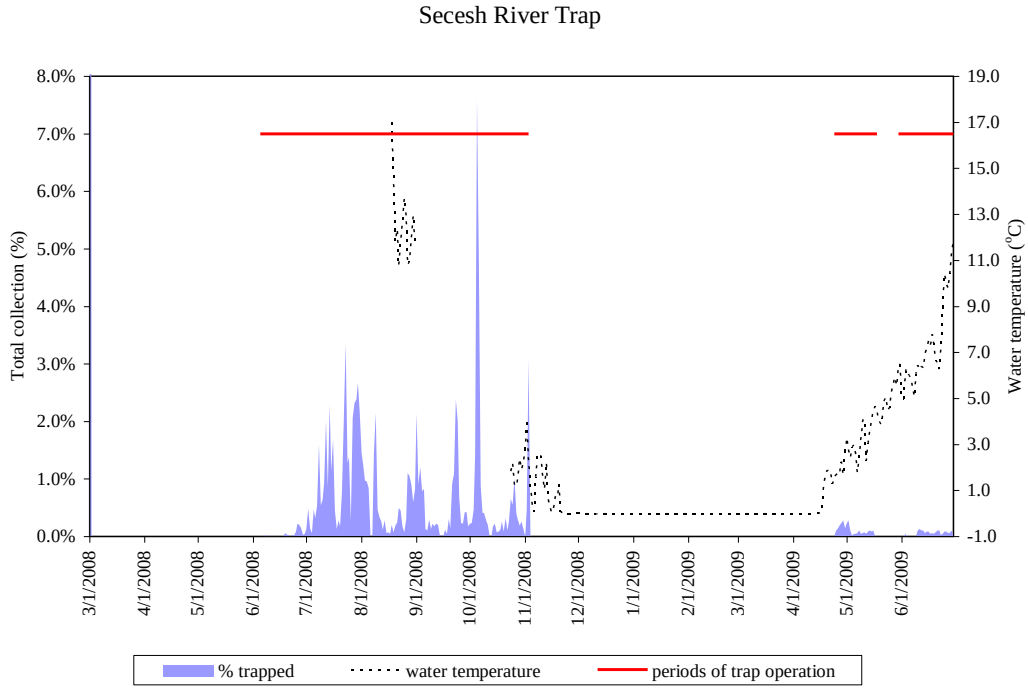
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min.	---	---	---	0.0	0.0	0.0	0.0	0.0	0.0	1.9	3.9	6.0
Max.	---	---	---	6.3	3.4	0.0	2.0	5.2	10.0	10.8	12.8	17.3
Ave.	---	---	---	2.3	0.2	0.0	0.1	1.2	4.0	5.5	6.9	10.7
						Depth (ft)						
Min.	---	---	---	0.6	0.4	0.6	0.4	0.4	0.6	1.4	2.2	1.5
Max.	---	---	---	1.7	2.0	3.4	3.2	1.7	2.2	3.6	3.4	2.4
Ave.	---	---	---	1.3	1.2	2.0	1.4	1.0	1.4	2.4	2.6	2.0



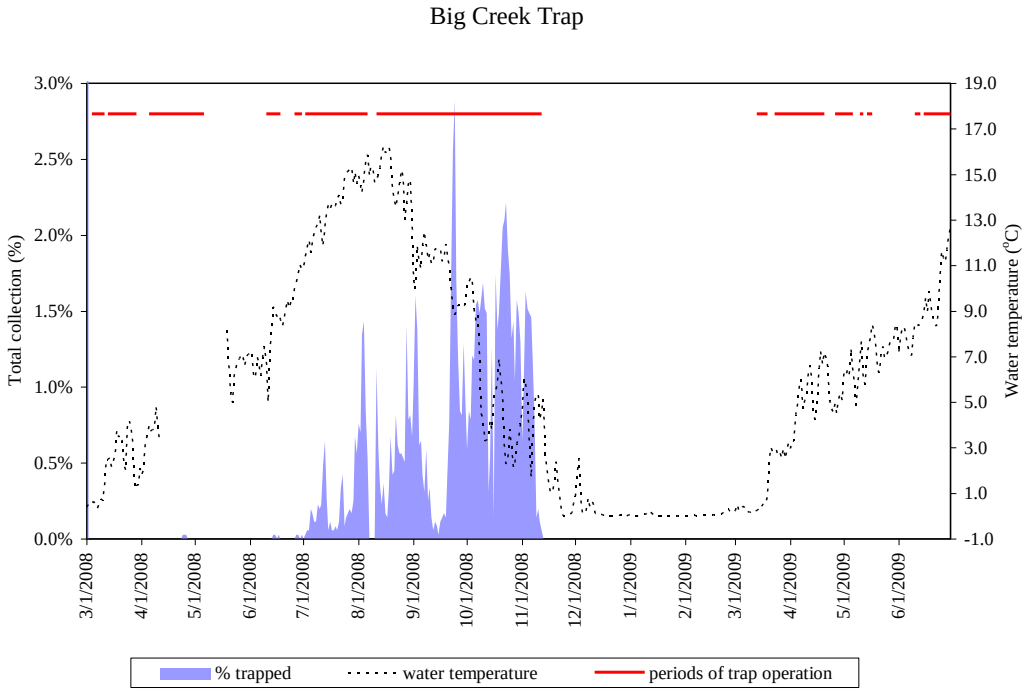


Appendix Figure 1. Daily passage of wild Chinook salmon fry, parr, and smolts at five migrant traps, expressed as percentages of total collected, and plotted against average daily water temperatures collected near traps. Periods of trap operation are also shown.

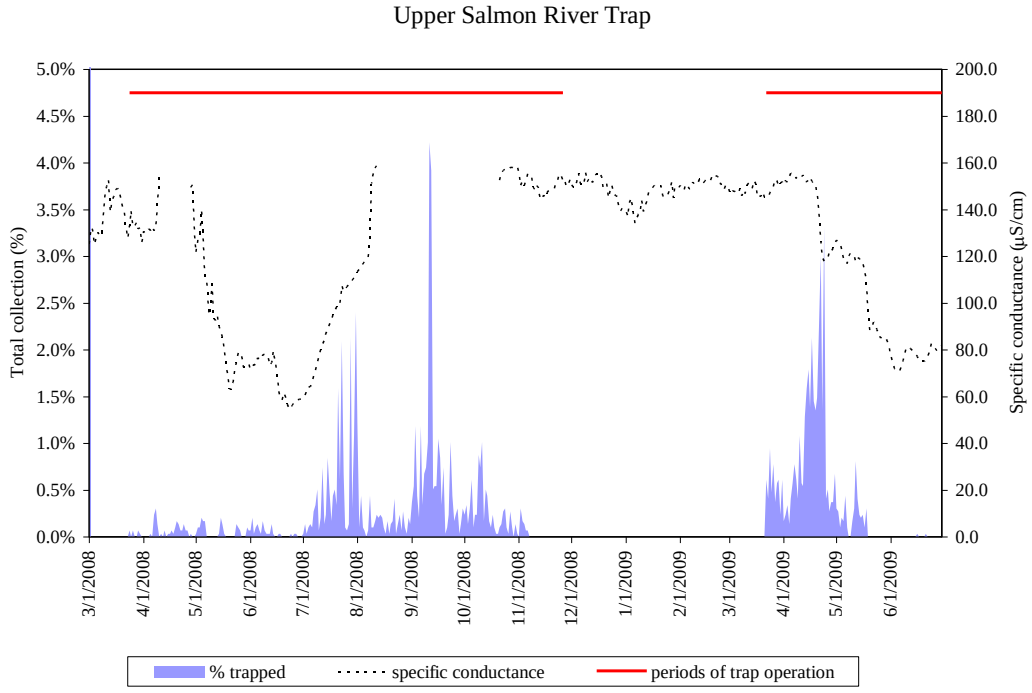




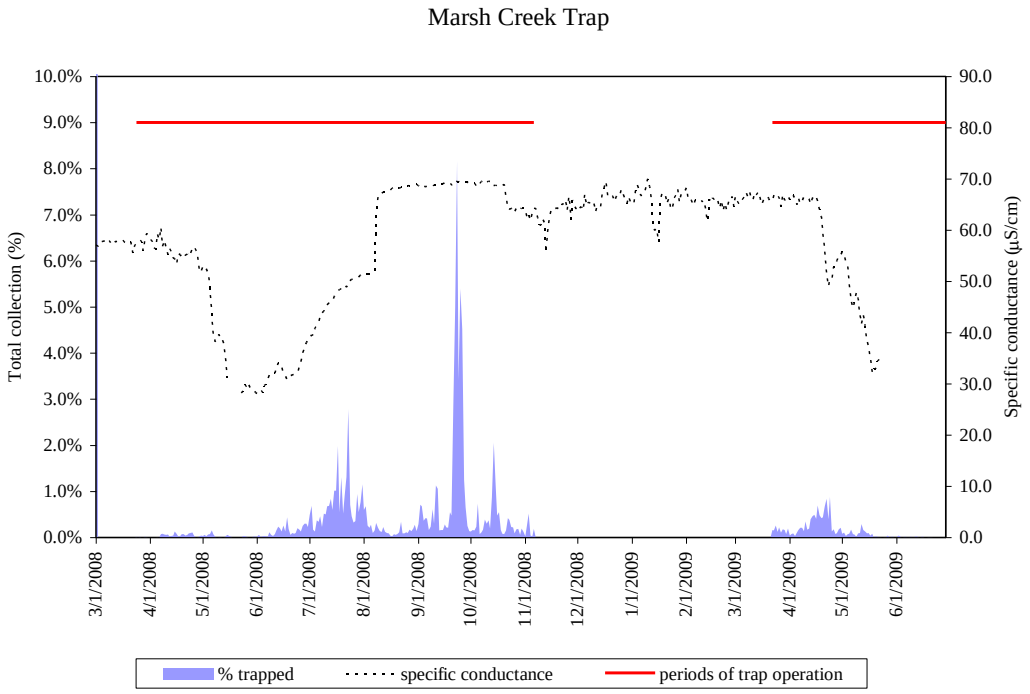
Appendix Figure 1. Continued.

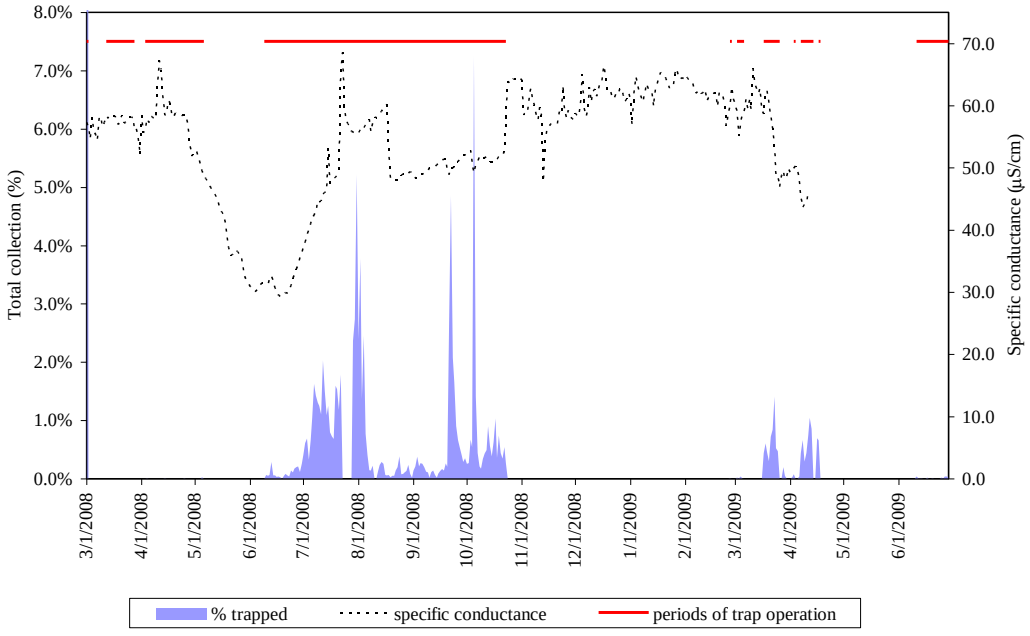


Appendix Figure 1. Continued.

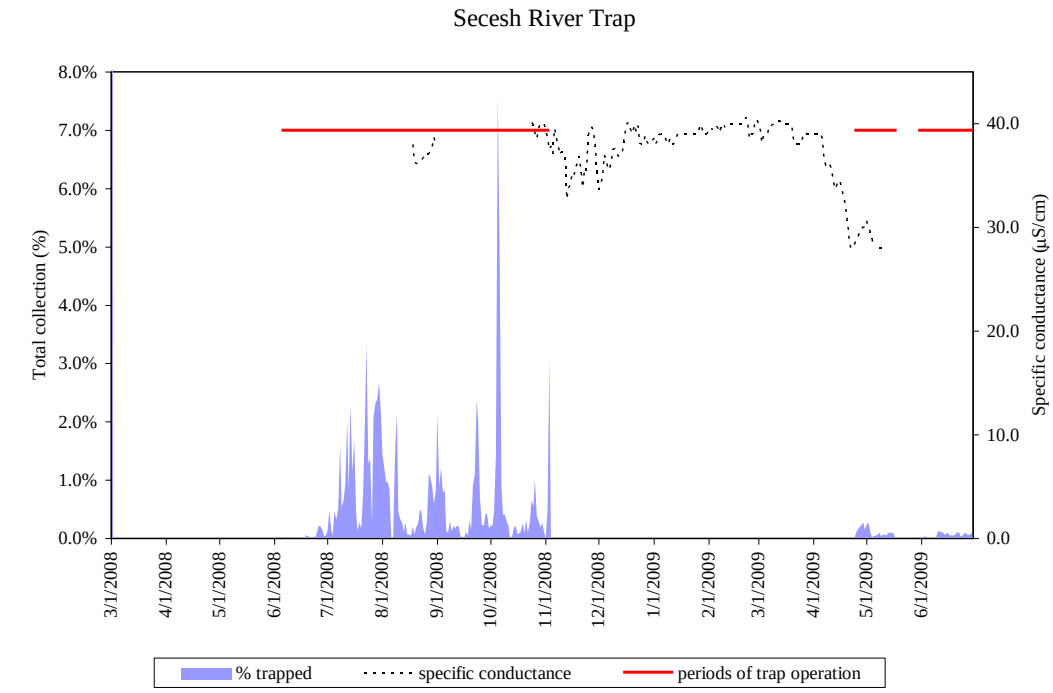


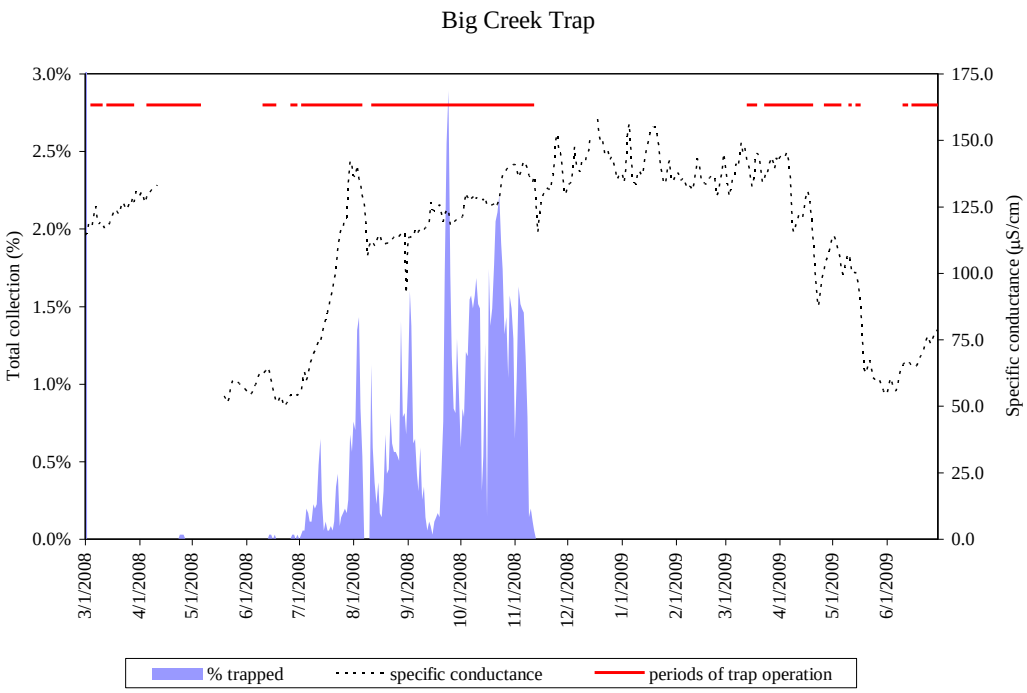
Appendix Figure 2. Daily passage of wild Chinook salmon fry, parr, and smolts at five migrant traps, expressed as percentages of total collected, and plotted against average daily specific conductance collected near traps. Periods of trap operation are also shown.



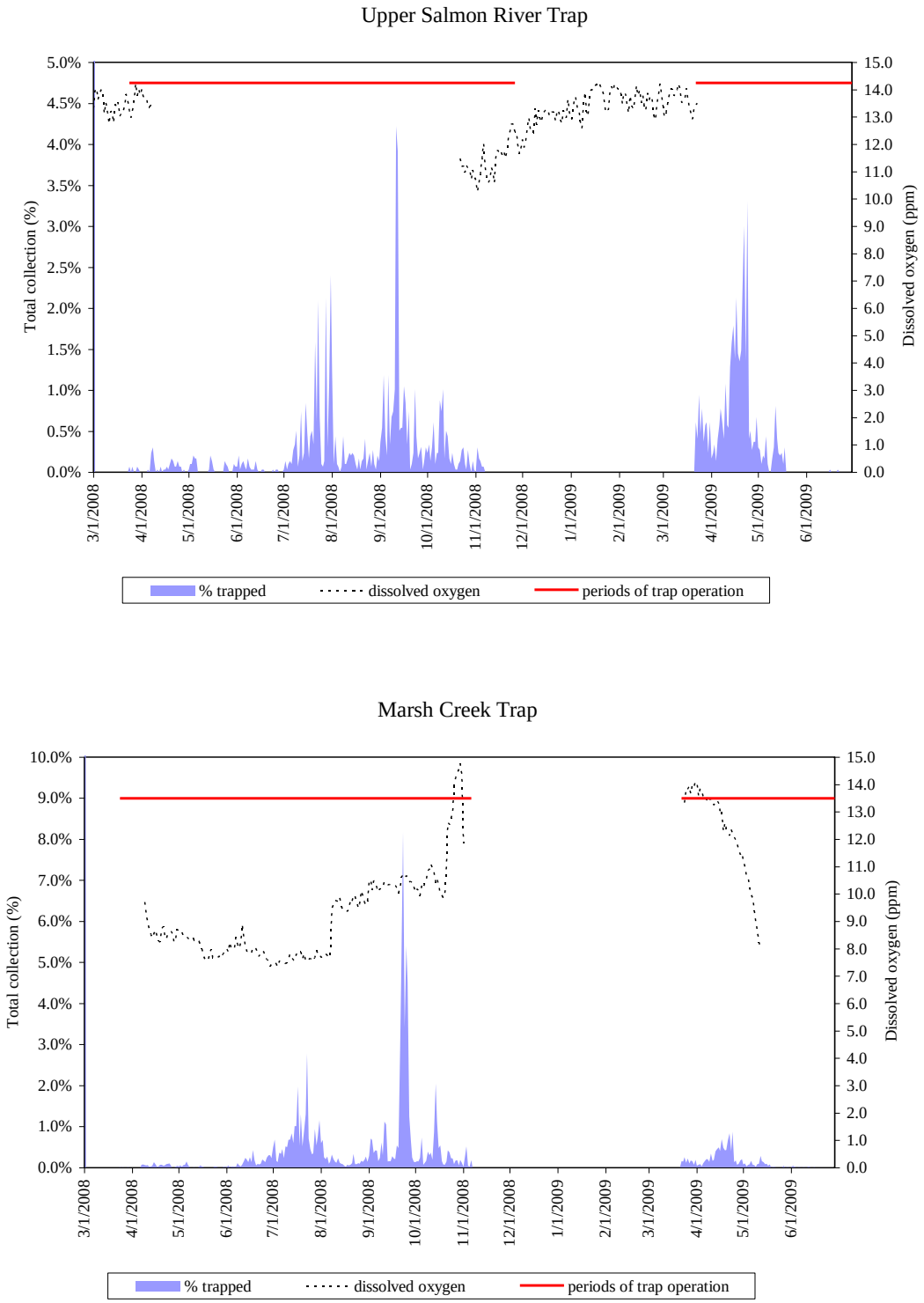


Appendix Figure 2. Continued.

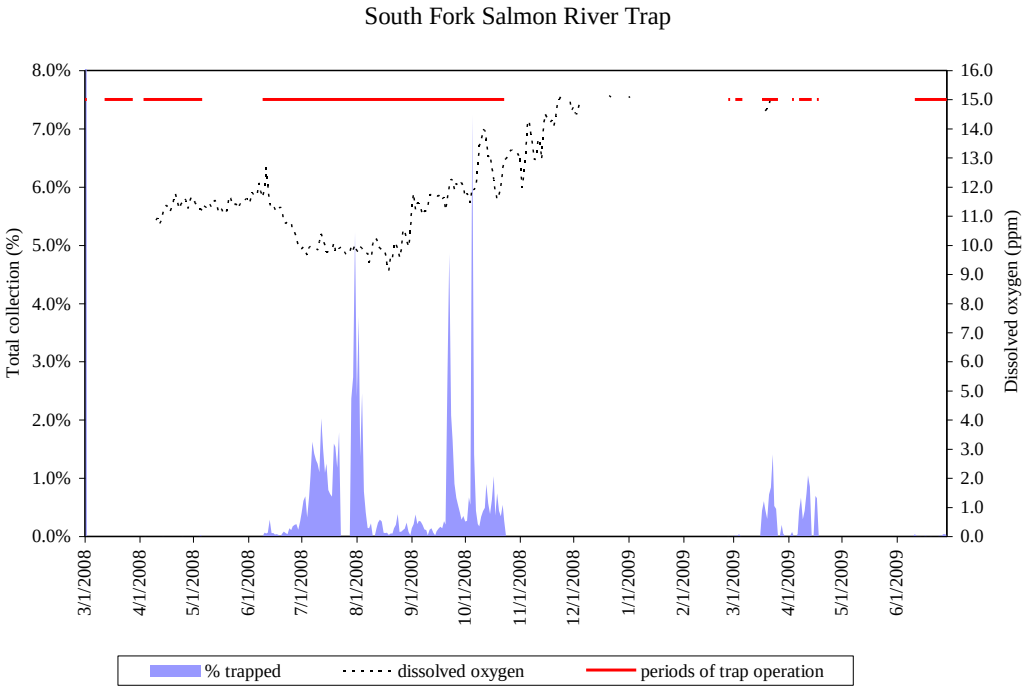


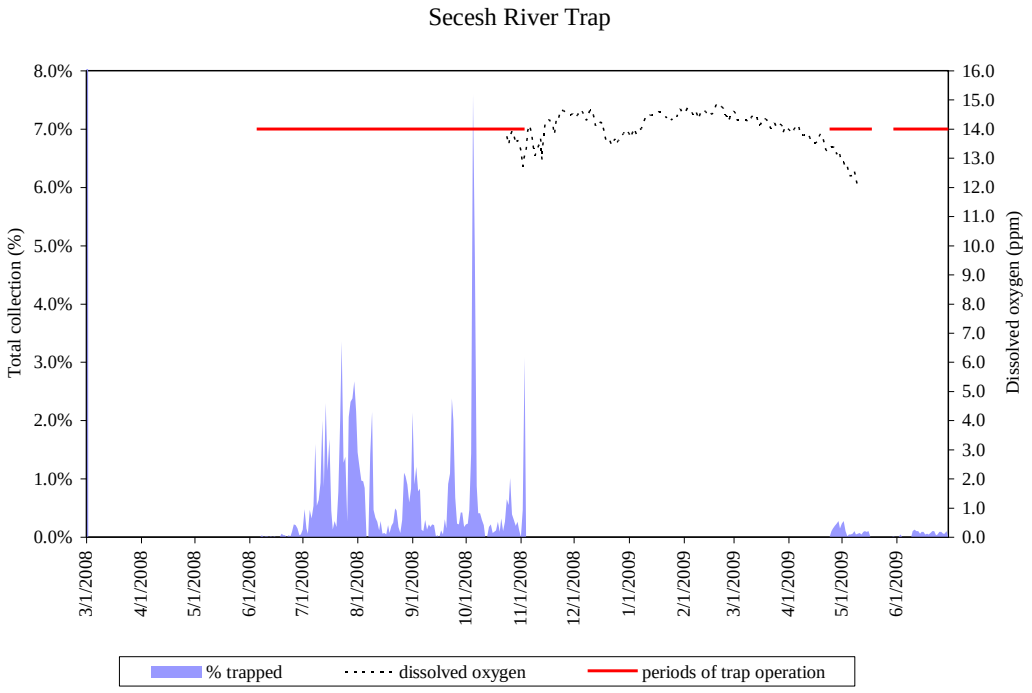


Appendix Figure 2. Continued.

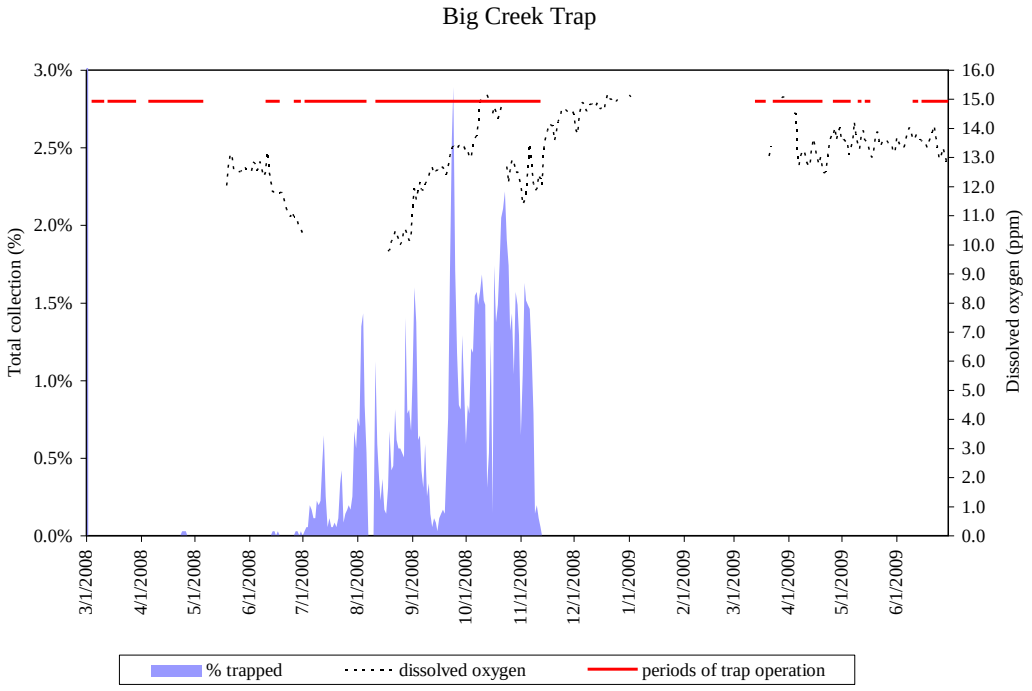


Appendix Figure 3. Daily passage of wild Chinook salmon fry, parr, and smolts at five migrant traps, expressed as percentages of total collected, and plotted against average daily dissolved oxygen collected near traps. Periods of trap operation are also shown.

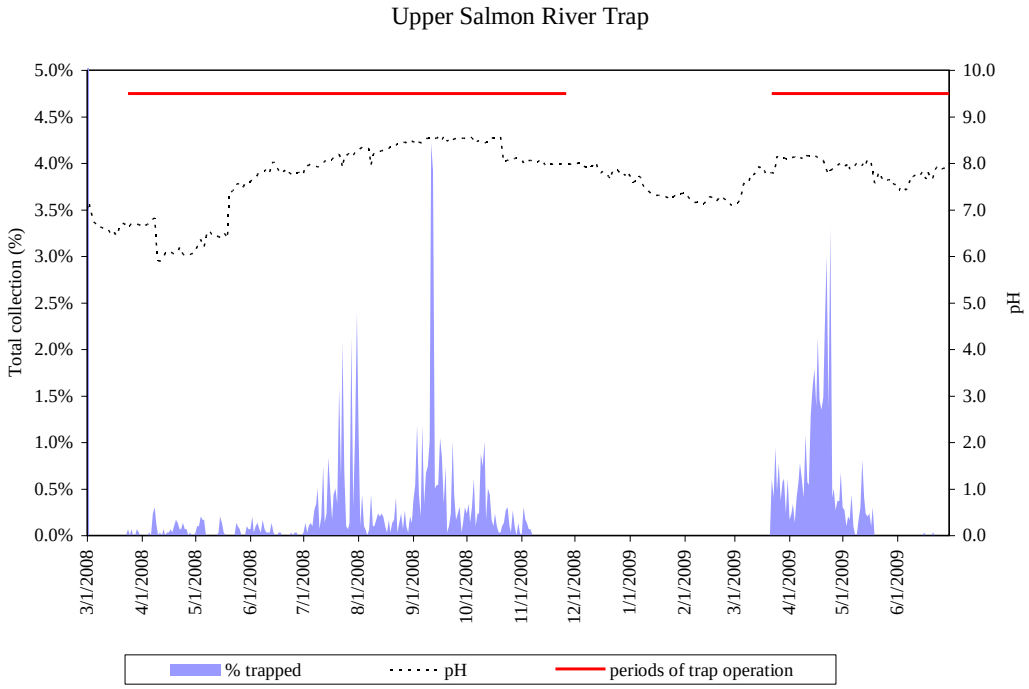




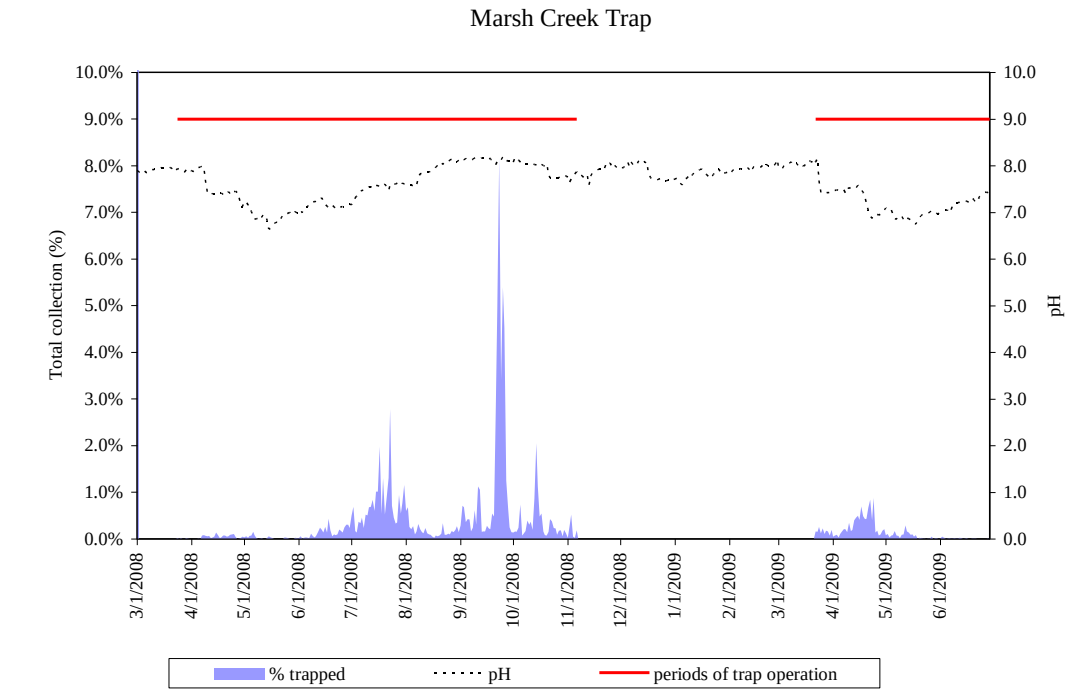
Appendix Figure 3. Continued.

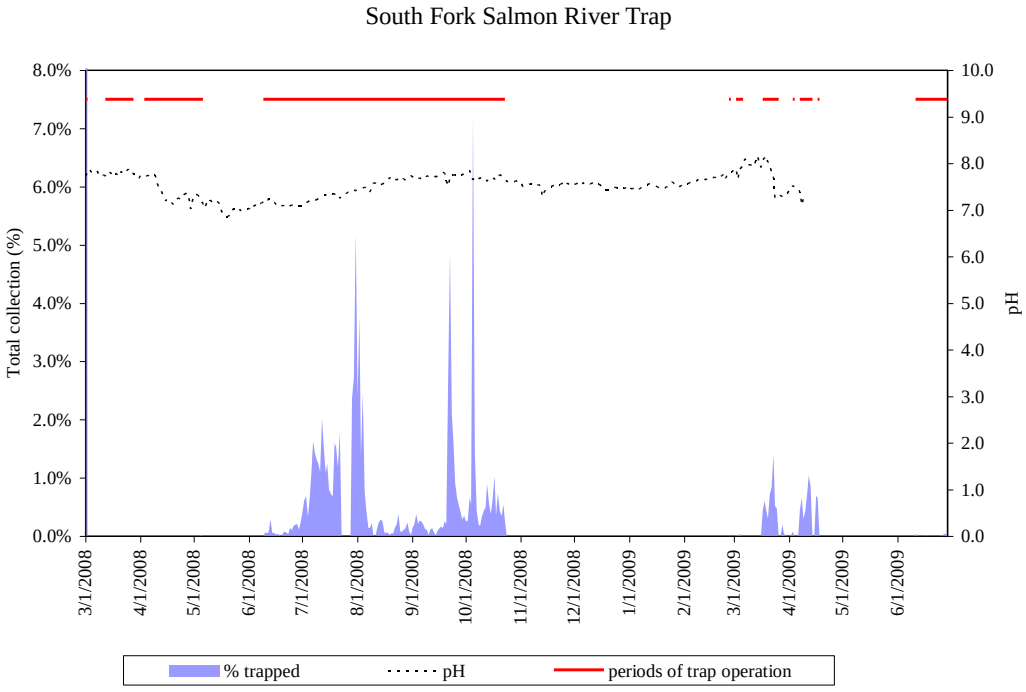


Appendix Figure 3. Continued.

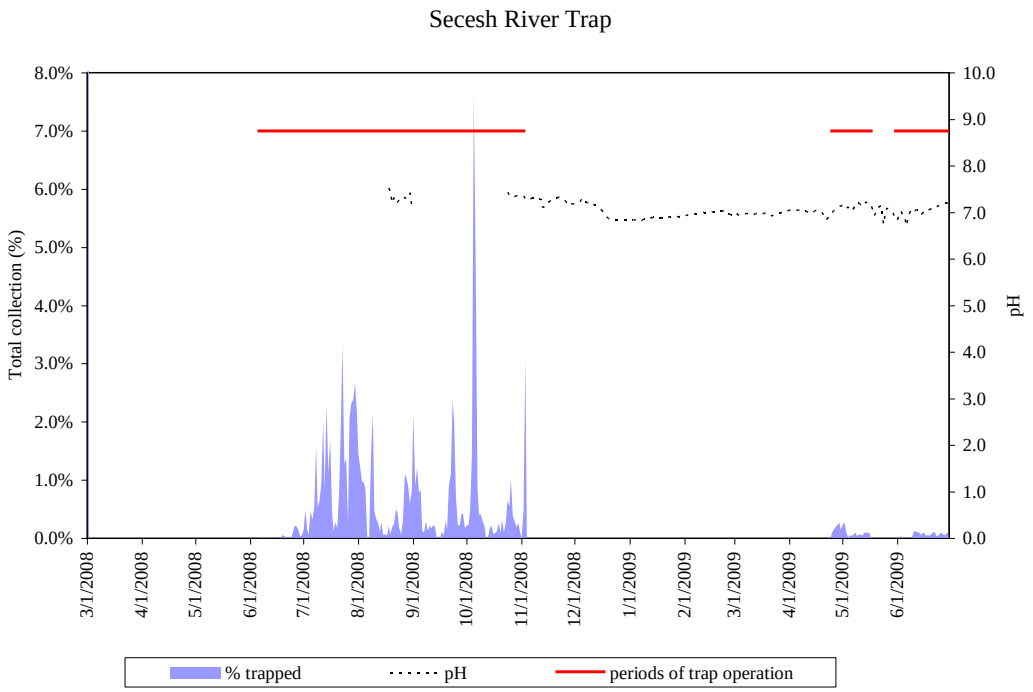


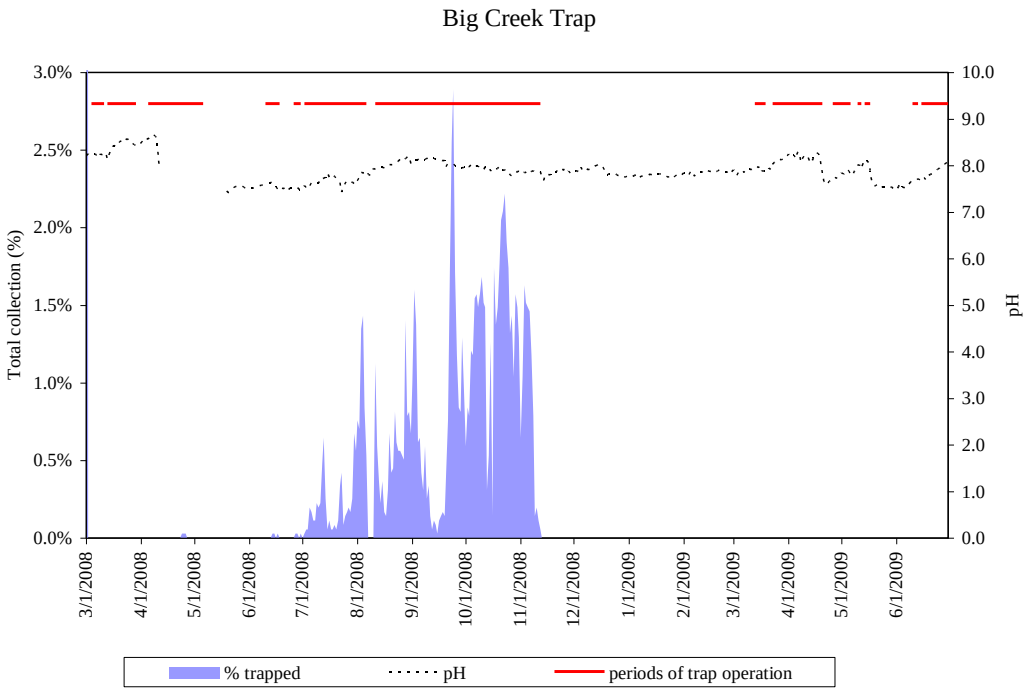
Appendix Figure 4. Daily passage of wild Chinook salmon fry, parr, and smolts at five migrant traps, expressed as percentages of total collected, and plotted against average daily pH collected near traps. Periods of trap operation are also shown.



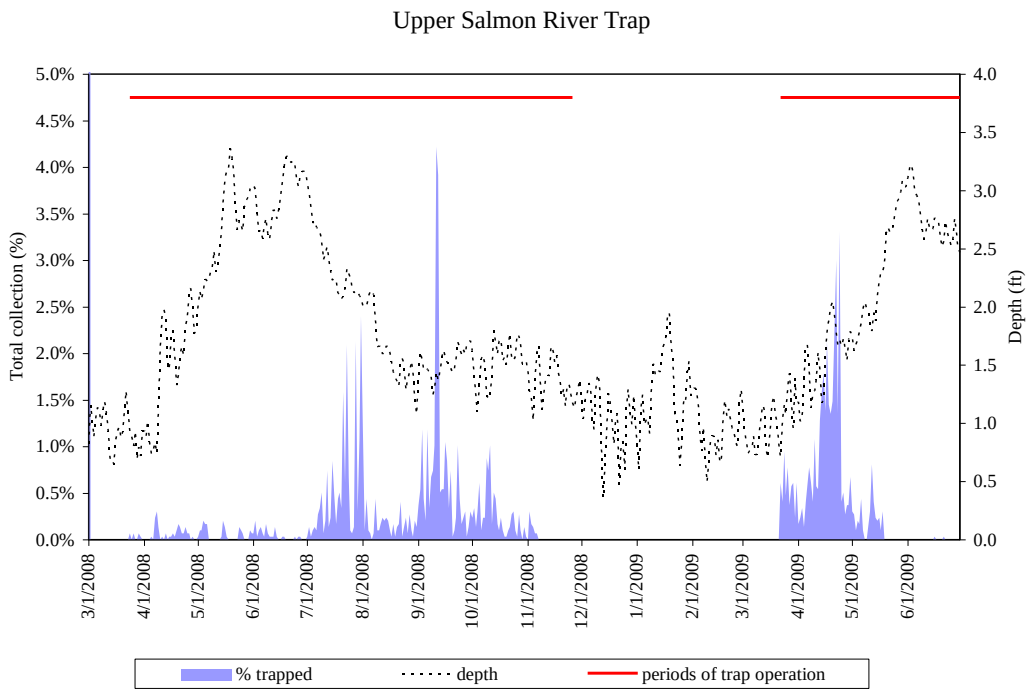


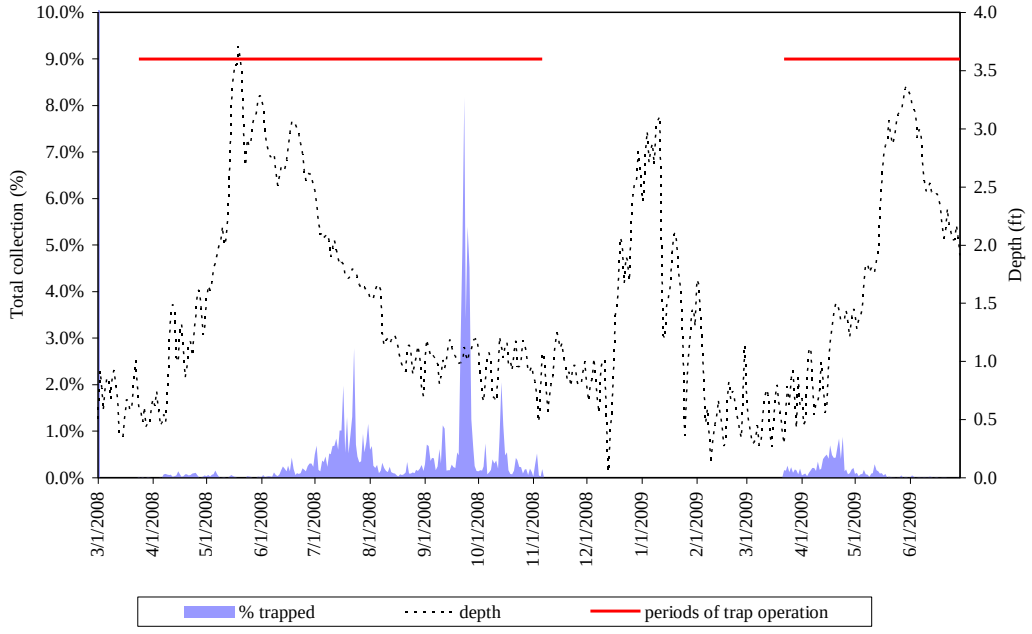
Appendix Figure 4. Continued.



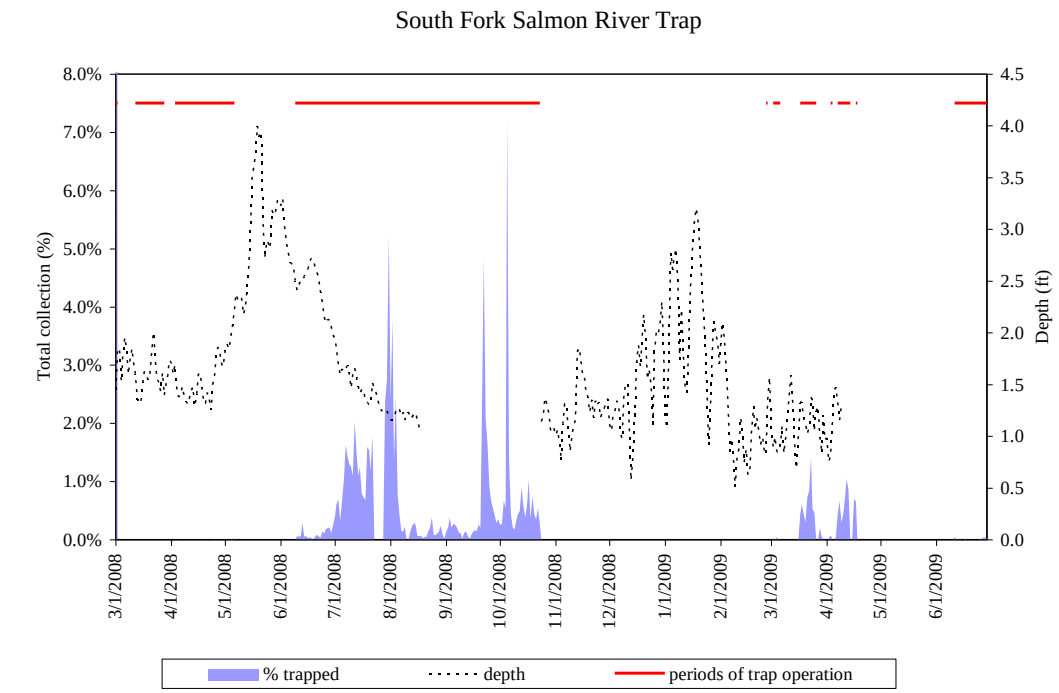


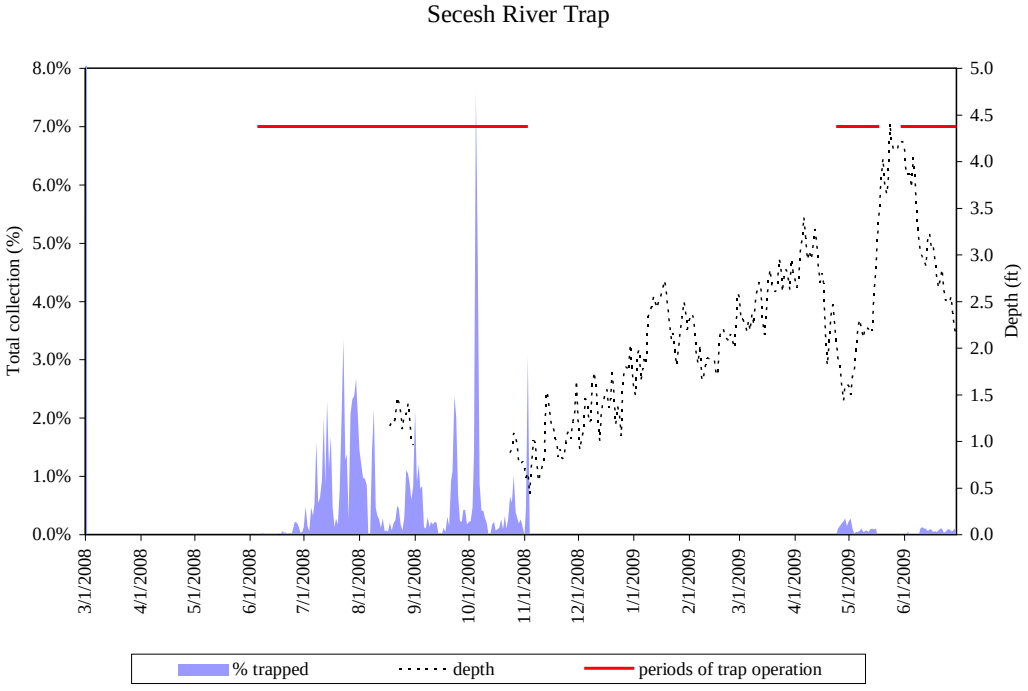
Appendix Figure 4. Continued.



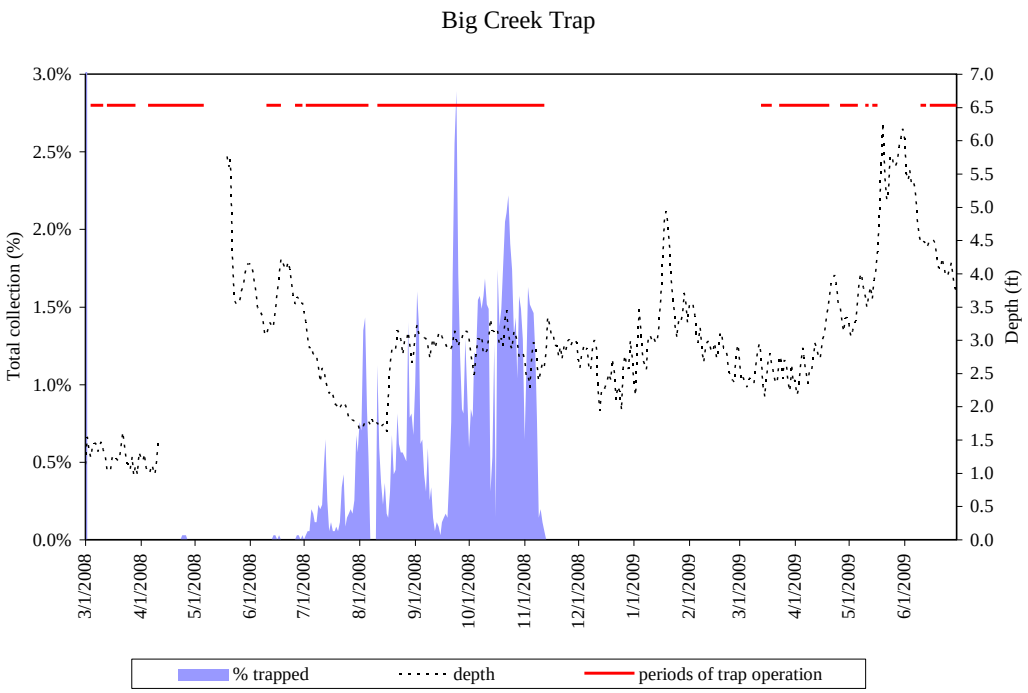


Appendix Figure 5. Daily passage of wild Chinook salmon fry, parr, and smolts at five migrant traps, expressed as percentages of total collected, and plotted against average daily depth collected near traps. Periods of trap operation are also shown.

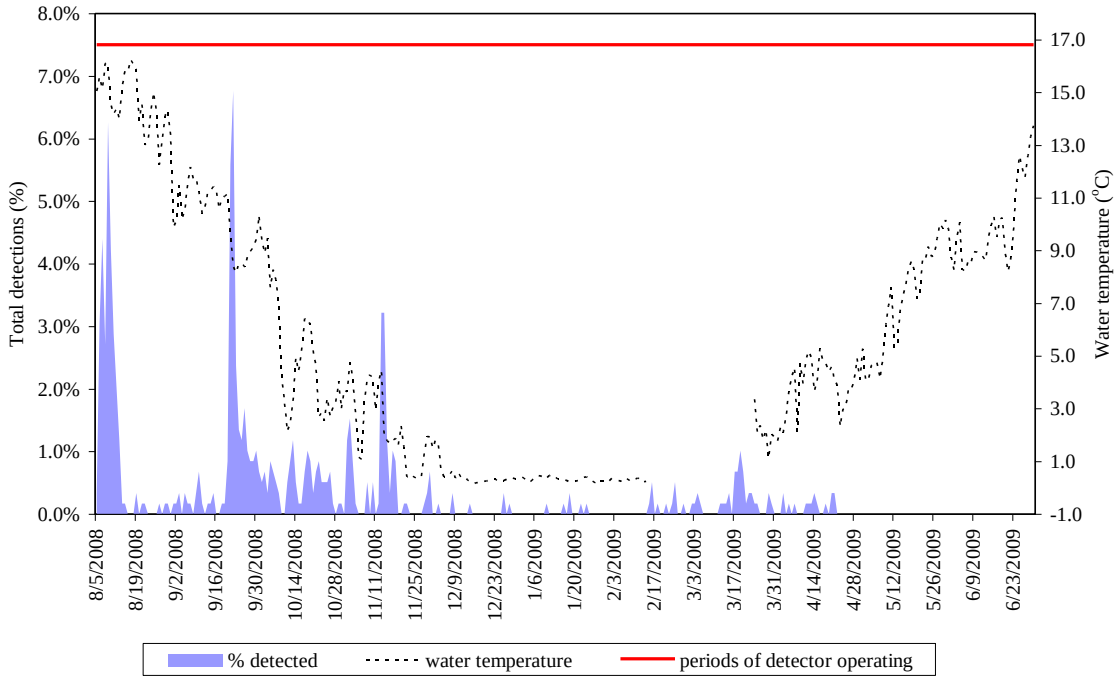




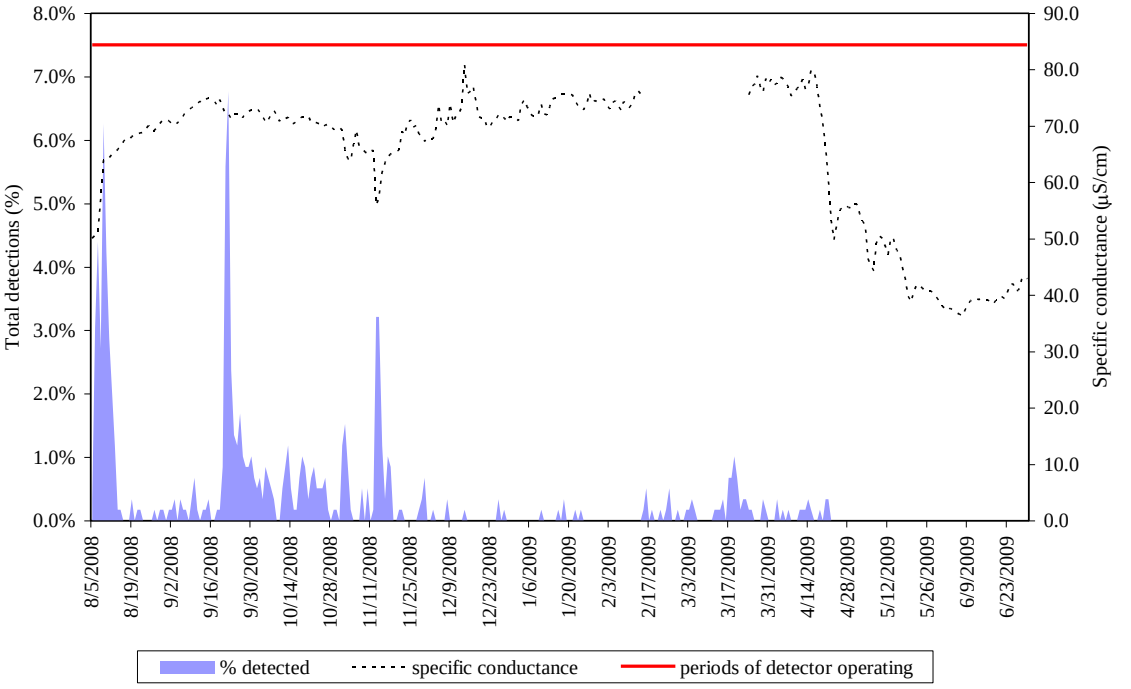
Appendix Figure 5. Continued.

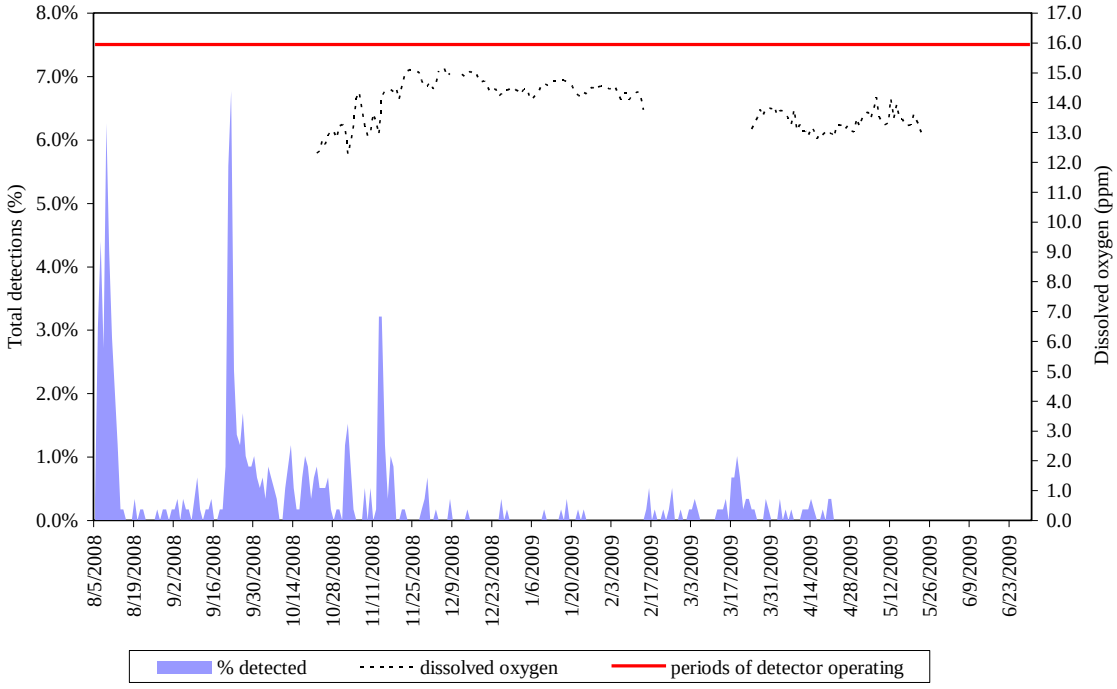


Appendix Figure 5. Continued.

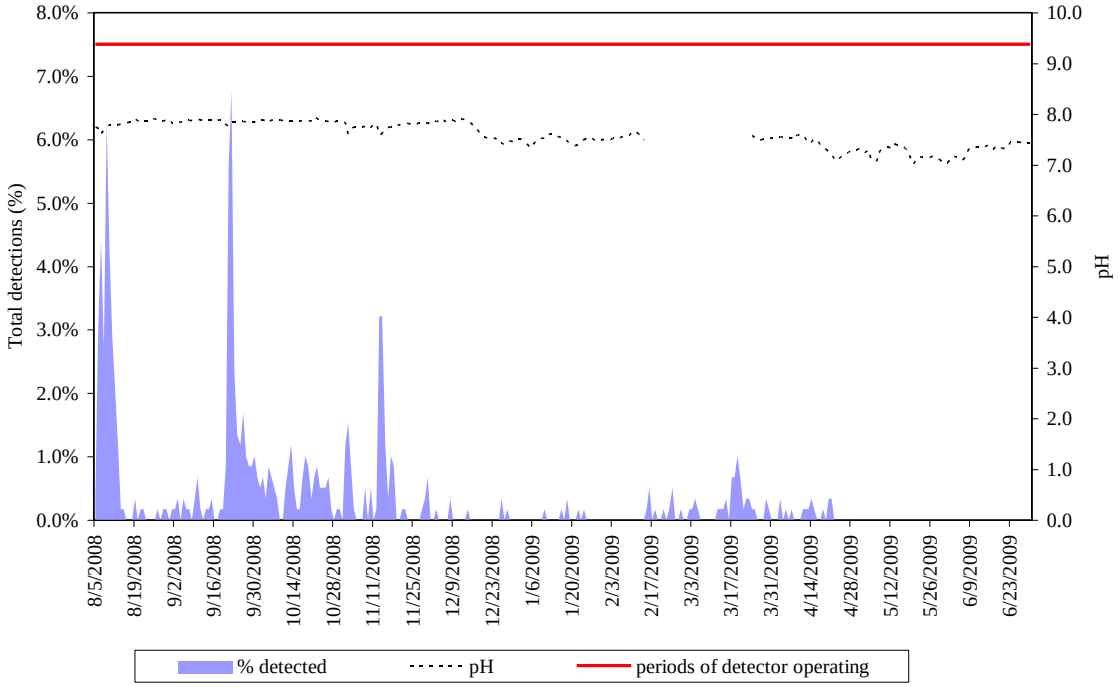


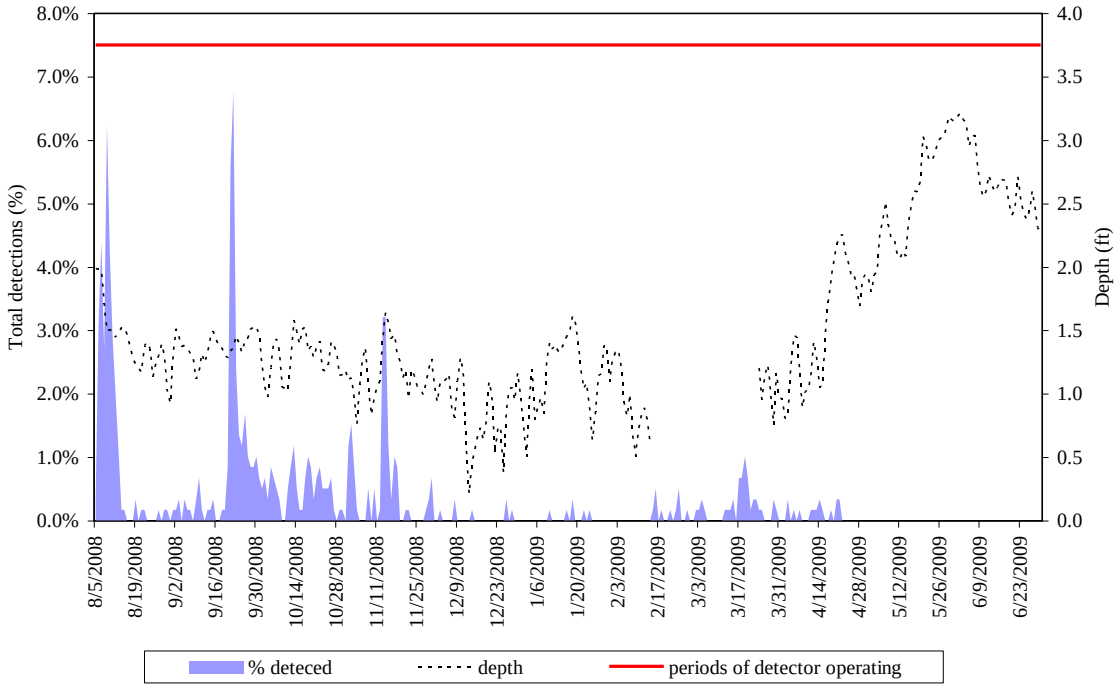
Appendix Figure 6. Combined daily PIT-tag detections of wild Chinook salmon parr and smolts at in-stream PIT-tag detectors in Valley Creek, expressed as percentages of total collected, and plotted against average daily aquatic conditions collected near the detectors. Periods of operation for the detectors are also shown.





Appendix Figure 6. Continued.





Appendix Figure 6. Continued.